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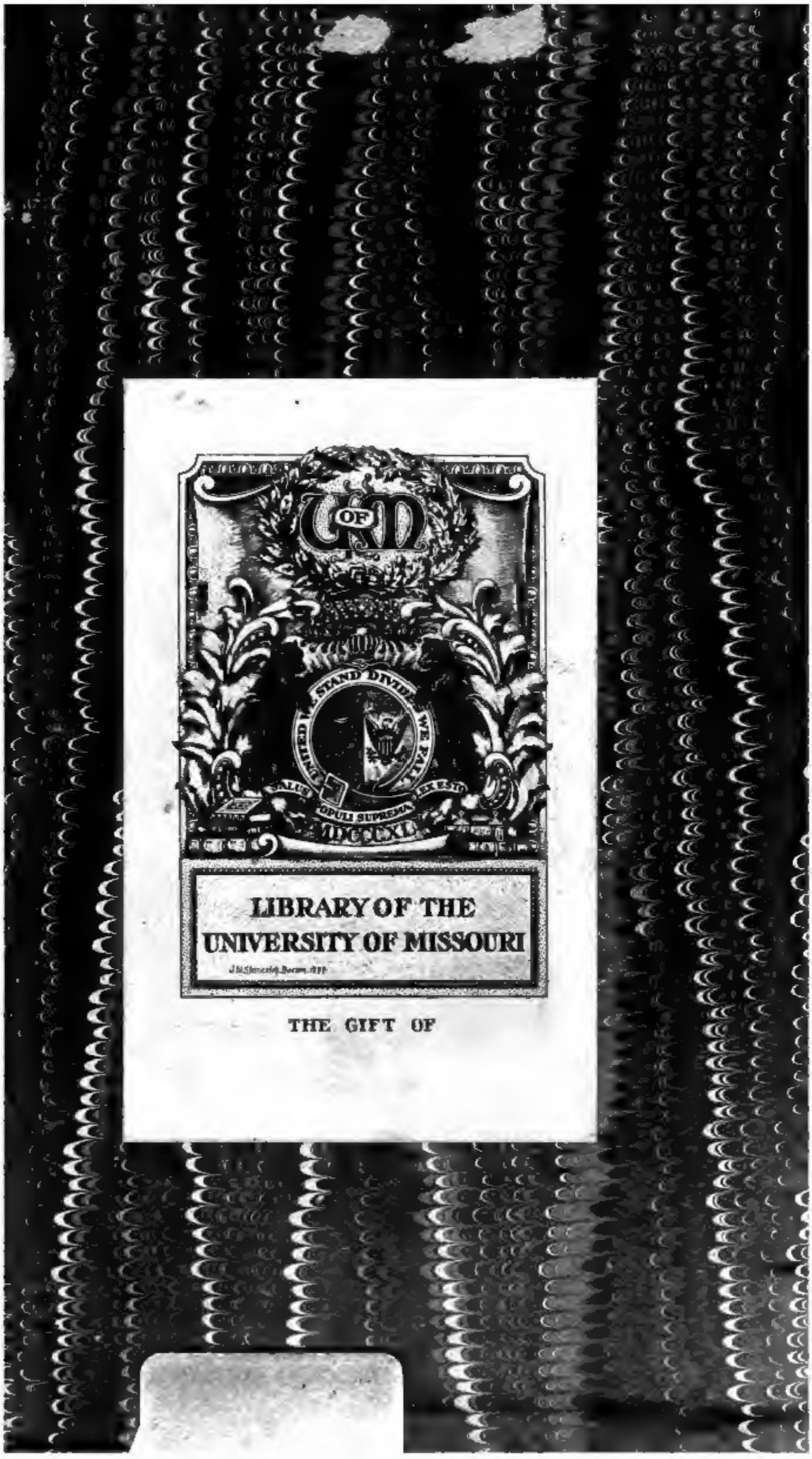
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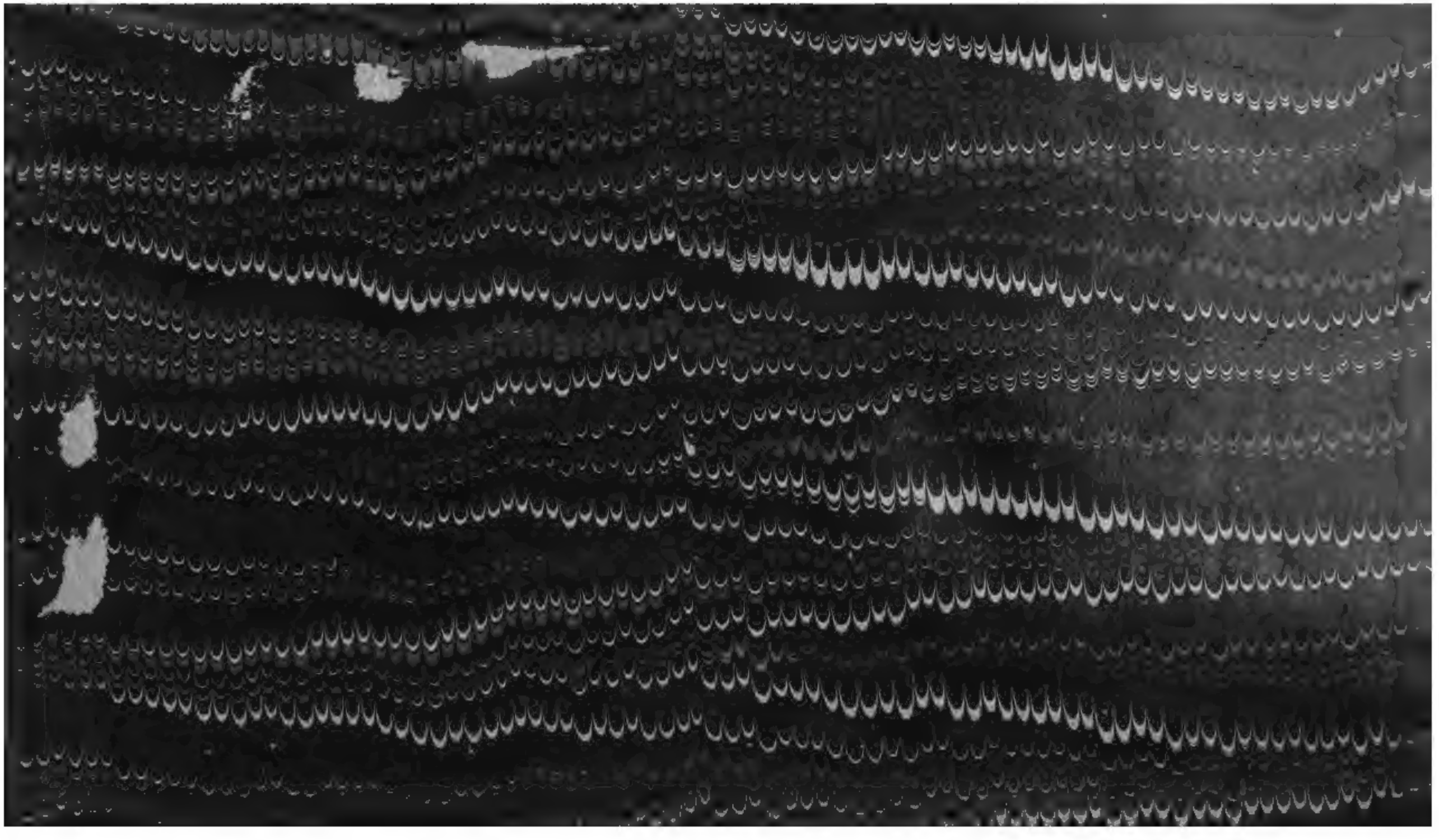

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51ST CONGRESS, 1st Session. | SENATE. | REPORT 928, Part 4.

REPORT

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VOL. III.—ROCKY MOUNTAIN REGION AND GREAT PLAINS.

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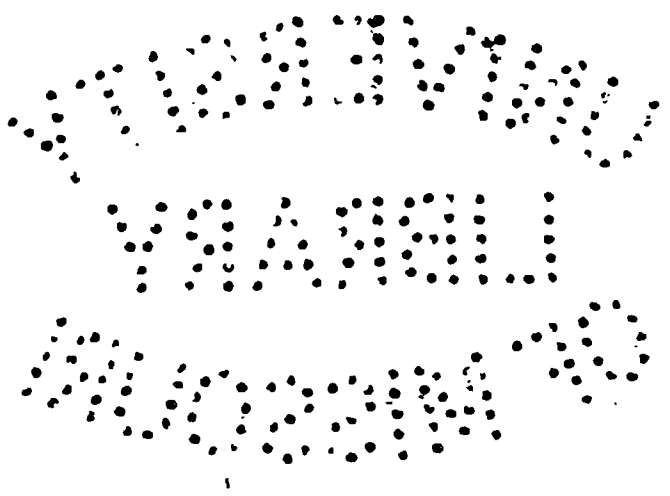
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VOL. III.

ROCKY MOUNTAIN REGION AND GREAT PLAINS.

EL PASO AND LOWER RIO GRANDE (TEXAS).
NEW MEXICO.
THE STAKED PLAINS (TEXAS).
WESTERN KANSAS.
COLORADO.
WYOMING.
WESTERN NEBRASKA.

EL PASO AND LOWER RIO GRANDE (TEXAS) DIVISION.

EL PASO, TEX., *September* 6, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF EDGAR B. BRONSON, OF EL PASO.

The CHAIRMAN. Are you familiar with western Texas and New Mexico?

Mr. BRONSON. To a considerable extent.

The CHAIRMAN. What opportunities have you had to become acquainted with those sections of the country?

Mr. BRONSON. The opportunities that a man will have who has been handling cattle over a considerable portion of the country to which you refer.

The CHAIRMAN. Commencing with New Mexico, state what you know of the irrigation that is practiced there, the water supply, and the practicability of increasing the acreage of land that may be cultivated by irrigation.

Mr. BRONSON. The bulk of the irrigation carried on at this time in the Territory of New Mexico is practiced under the old Mexican system. It is only within the last three or four years that anything has been done in reference to the coming in of organized capital with a view to developing the water supply. The water supply as a rule is meager. There is an abundance of water in the mountains, rising to great bold streams at the foot-hills, where it sinks in large sections. It only needs to carry that water out in canals to indefinitely increase the area of tillable lands in the Territory.

The CHAIRMAN. I believe the Rio Grande is nearly dry; no water running in it. Does that often occur in summer?

Mr. BRONSON. Very rarely occurs. It has occurred in seasons of extraordinary drouth. But new conditions are coming up—conditions similar to those that exist in the South Platte River in Colorado. That river flowed a great bold stream to its mouth, but the taking out of the cañons has run such a drain on the river that after the snow waters and spring waters are taken away it is dry almost its entire length. The same conditions are succeeding here in the Rio Grande Valley. Formerly, when it was necessary to irrigate the land, there was an abundance of water in this river; but at the present time the conditions are rapidly changing to the conditions that exist on the Platte. The changes made upon the river in the San Luis Valley are rapidly affecting the supply.

The CHAIRMAN. How is that affecting the inhabitants below?

Mr. BRONSON. To their absolute ruin. It means absolute ruin to the plantations of the *Rio Grande* from Albuquerque south. The crops a

dying, and it is impossible to make any crop except one of corn. I mean that it is impossible to make a crop of small grain—wheat or barley. There will be water enough to make a crop that is planted in the late winter and harvested in June; but the crop that is planted on the same land early in July and harvested in the autumn may not be longer made, nor may the fruit crop be ripened.

The CHAIRMAN. Does it affect people on the Mexican side of the line as well as those in the United States?

Mr. BRONSON. Equally. And it affects them to a greater extent, because the settlement there is older and the acreage of tillable land is larger.

The CHAIRMAN. And perhaps the inhabitants there are dependent upon agriculture?

Mr. BRONSON. The inhabitants on the Mexican side of the river you may say are entirely dependent on agriculture, for this reason: They have no manufactures. The mass of the people are agriculturists, and those who are not, are merchants who depend on the farmers for trade.

The CHAIRMAN. About what is the population of the valley on the Mexican side?

Mr. BRONSON. On the Mexican side, from the line above Quitman Cañon, there is a population—I think it would be a moderate statement to say of 25,000.

The CHAIRMAN. About what is the population on the United States side that are affected in the same way?

Mr. BRONSON. Within a radius of 25 miles of El Paso there is, roughly estimated, about 40,000 to 45,000 population. That is the population of the valley proper that is affected by these conditions. Within the valley above Las Cruces, Mesilla, San Marcial, and Albuquerque there is an arid country with a population surely of not less than 30,000 who are directly affected by the stopping of the water supply of the river in the ditches of the San Luis Valley and below. There a ditch was taken out and nearly finished, having a length of 60 miles, which takes out about the last available supply from that stream.

The CHAIRMAN. What amount of water runs to waste in this river in flood-time?

Mr. BRONSON. That is a question of a technical nature that I can not answer.

The CHAIRMAN. It has not been gauged?

Mr. BRONSON. It has been gauged, and Major Mills can afford you information upon that subject. I can say that for three or four months of the year it runs at flood and the channel is full, and then there is an abundance of water for all the land that the ditches could be brought to.

The CHAIRMAN. If the water is stored, you think there is an abundance of water in the Rio Grande to furnish water to all the land?

Mr. BRONSON. To every acre that could be put under cultivation. It flows a great bold river every year through the periods of the flood, through all the winter months, and up to the middle of June or July.

The CHAIRMAN. What amount of land is there in the United States that can be irrigated from the Rio Grande, if the water were preserved?

Mr. BRONSON. That again is a very difficult question to answer.

The CHAIRMAN. It only calls for a rough estimate. It is a large quantity, is it not?

Mr. BRONSON. We have in the valley of the Rio Grande, from here to Quitman, 75,000 acres. In the Las Cruces Valley and in other valleys there are probably 250,000 acres. That is pretty close. As to what

there is in the San Marcial Valley and from there up, I can not say. I should think a million acres a very low estimate.

The CHAIRMAN. Are you familiar with the topography of the country at the source of the Rio Grande?

Mr. BRONSON. To some extent. I have been in that country. It rises in the high mountain ranges of southern central Colorado, and flows thence through the San Luis Valley, and then through the cañons of northern New Mexico, coming out on the valley and plains below.

The CHAIRMAN. What other irrigating enterprises have been inaugurated or contemplated in New Mexico besides those waters directly from the Rio Grande?

Mr. BRONSON. Only two on anything like a large scale. One concerns the development of the Maxwell grant, in northern Mexico, of which you doubtless know a great deal. The streams are small, and they are confined to a system of small canals which they are proceeding to take out. They have availed themselves of the entire water supply, and that land is put upon the market at from $10 to $15 an acre.

The CHAIRMAN. Have they made an effort at the storage of water?

Mr. BRONSON. To no considerable degree. They have some small dams. The other enterprise which has been attempted is that of the Pecos Valley Irrigation and Investment Company.

The CHAIRMAN. You are interested in that?

Mr. BRONSON. Yes, personally.

The CHAIRMAN. Will you describe that?

Mr. BRONSON. The conditions are these: The Pecos River, like the Rio Grande, rises in Colorado. It flows to a point about Fort Sumner, where it sinks every year a distance of 80 miles. Then there comes in from the mountains on the west, striking out from the margins of the river, a series of springs, which create the Lower Pecos. There a ditch is taken out 37 miles long and 35 feet on the bottom. It is taken to a point 35 miles from there, where a series of new springs break out from the mountains affording another supply to the river, from which there is another canal 58 miles long and 45 feet on the bottom. The two canals will irrigate about 300,000 acres of land as now planned. It is then the contemplation of the company later to take those ditches along the line into Texas, and it is the expectation of the company that the amount of land will not be doubled, but very near it.

The CHAIRMAN. Do you contemplate storage reservoirs to save the storm waters?

Mr. BRONSON. There is no necessity for that under our present plans. That will become a practical question when the water supply of the river is run short. But we have an abundant supply for at least half a million acres. That is a definite calculation by one of your own engineers, Mr. Nettleton, of Colorado—that is to say, he is one of Director Powell's engineers.

The CHAIRMAN. By storage and the saving of water to its utmost extent you might increase the number of acres.

Mr. BRONSON. It may be indefinitely increased, because there are points where you could conserve the water through the winter. But there are no uses for it; it would simply run to waste.

The CHAIRMAN. Then your additional land will be in Texas?

Mr. BRONSON. The additional land will be in the State of Texas.

The CHAIRMAN. Making a rough estimate, about how much land in Texas could be reclaimed should you exhaust that water supply?

Mr. BRONSON. I believe over a million and a half in Texas; because the lower *you go to the point* where we take out these canals it is very

narrow, but passing the Texas line the canal widens, and it could be carried out at least 30 miles from the river to a point down about Live Oak Springs, below Fort Stockton, a great broad valley being on the west.

The CHAIRMAN. What is the character of the land?

Mr. BRONSON. It is a loose red, sandy loam, and very deep soil underlaid with limestone. With the storage of water the possibilities of that enterprise are so large it is very difficult to state them accurately.

The CHAIRMAN. How much of a river is the Pecos in flood-time?

Mr. BRONSON. It is a river probably 150 to 175 feet wide, and from 20 to 25 feet deep. It is a very peculiar stream. It is narrow and deep. I have never seen anything like it in the West.

The CHAIRMAN. Has it a rapid current?

Mr. BRONSON. Very rapid current—a sharp fall all the way. That is an important feature in the quantity of the supply of the water. It is a very rapid stream. The extent of the water that could be stored in the four months of idle season, in winter, is almost indefinite.

The CHAIRMAN. Have any streams been taken out?

Mr. BRONSON. Small streams have been taken out at Pecos City, on the Pecos River, about 50 miles below Mexico.

The CHAIRMAN. How far is it from where you start, following down the river to the Texas Pacific Railroad?

Mr. BRONSON. From the head of the northern canal it is 185 miles.

The CHAIRMAN. And you occupy with your canal what portion of that district?

Mr. BRONSON. When the canals shall have been completed we will occupy the country to a point within 50 miles of the railway. We will occupy 130 miles of the Pecos. There is a break between of undesirable country that need not be covered. It is indefinite, but the canal system could be carried down farther south 100 miles at least if there were water sufficient.

The CHAIRMAN. What products do you raise there?

Mr. BRONSON. Everything that is raised in this section of the country—all varieties of fruits. The country produces two good crops a year. The small grain crop—barley and wheat and all that sort of thing—is harvested in spring, and corn can be put on the same ground and harvested in the autumn, but that is not deemed the most desirable crop. Then we are nearer the markets than California.

The CHAIRMAN. What kind of fruits can you raise?

Mr. BRONSON. We raise everything except the purely tropical fruits. The orange, olive, and such things have been tried in the Pecos, and they are doing very well. The grape, apricots, figs, and all kinds of apples can be raised.

The CHAIRMAN. Are there any other opportunities for irrigating in Texas further east except on the Pecos?

Mr. BRONSON. Yes, on the Nueces.

The CHAIRMAN. Where does that river rise?

Mr. BRONSON. That rises in the Blue Range, north of San Antonio, and flows generally south through southern Texas into the Gulf.

The CHAIRMAN. How much of a river is that?

Mr. BRONSON. It is a dry stream below, after coming out of the mountains. But coming down it is a stream that will run 100 feet wide at the cañons, and be 78 feet deep. It is a large stream. There is a project to take the water from the cañon of the Nueces and carry it east *out of* the valley. A charter is granted for that purpose, and the company *has been organized.*

The CHAIRMAN. What crops can be raised on the plains of western Texas without irrigation?

Mr. BRONSON. Nothing. In seasons of heavy rains occasionally a light crop of corn is made. But it is so entirely untrustworthy that it is not mentioned.

The CHAIRMAN. You have been over the Nueces and understand the topography of the country at its source. State whether there are any opportunities there for storage reservoirs.

Mr. BRONSON. The opportunities are excellent, because the character of the country is especially adapted to that purpose. The streams lie deep, and they are crossed at different points by dikes of rocks, at which points storage reservoirs or dams could be made without great expense. When you get down to that lower country, as a rule the streams are broad, and they flow great bodies of water. At those points cheap dams could be put in that would accumulate the water and make possible the tillage of a great deal of land.

The CHAIRMAN. Is there any person you know who is familiar with that region of country and who can give us a report on it?

Mr. BRONSON. I do not know of any one here at the present time.

The CHAIRMAN. How can we get that information without traveling over the country? In the absence of railroads it would be difficult for us to travel over these sections.

Mr. BRONSON. You mean southwestern Texas?

The CHAIRMAN. Yes; and in northern Texas where irrigation is required.

Mr. BRONSON. I should think that Mr. Streeruwitz, the State geologist, could give you that information.

The CHAIRMAN. Are there any other facts in regard to Texas and Mexico that you would like to state?

Mr. BRONSON. I would like to state what are the local conditions here at El Paso: We have a proposition here, the suggestion originally of Major Mills, for the building by the Government at this point of a great international dam. He has studied the matter, and has brought it down to a pretty definite set of figures, which he will present to you. But in that connection I would like to say that we beg of you that you give that question very careful consideration, because it affects not only the question of irrigation of arid lands, but also the settlement and regulation of certain international difficulties that we have here—difficulties that must exist until this question shall have been settled. And the question involves the channel of the river. It is changing, and difficult and noisy litigation under international law comes up over these changes of the river channel. Now, there has been at this point, perhaps from the beginning of the settlement, a dam maintained exclusively at the cost of the people of Mexico on the other side, and without any contributions on our part, though it is being used by us with equal benefits. But they are now, in common with us, deprived of the water by the drain upon it in the ditches of the Colorado; and it seems to us a moral responsibility, if not a legal one, rests upon us to have the waters of the Colorado by some means stored. One way is to choke off these fellows in Colorado and New Mexico who have taken out the water in the face of an undeniable right. There should be a storage system here, by which the waters of the river could be retained in such quantity as to enable the people to cultivate their land under their original rights. We want you to study that question, as it is one of vital importance to the people of this section.

The CHAIRMAN. The *scope of our* power does not include a recom-

mendation for Government work. The Government has commenced engineers' surveys, and will designate reservoir sites, lines of ditches, etc., and will make estimates of the cost of construction, for the purpose of informing the people where they can make homes. The Government will reserve all the sites that may hereafter be designated as suitable for reservoirs, with the land that may be irrigated thereby. But the law making these reservations also provide that the President, by proclamation, may open these lands to homestead settlers. Now, we want to ascertain if any further legislation will be necessary in that direction, and if so, what? It is our duty to ascertain, first, whether the subject is of sufficient importance to justify the expenditure of so large an amount of money as will be necessary for this engineering work.

Mr. BRONSON. There is one other feature that I wish to suggest in this connection, and that is as to the desirability on the part of the Government of going into expenditures in the West to develop the arid land. Millions are appropriated yearly for the improvement of the rivers and harbors, the promotion of local commerce. We have no harbors to improve, no channels to deepen; but the commerce of this country can be fostered and promoted, developed and enlarged, by storage reservoirs comprehended in your present study.

Senator REAGAN. You were asked the question about what streams there were from which water might be applied to land, and you mentioned the Nueces. How is it with regard to the San Antonio?

Mr. BRONSON. I mentioned one way in which the project was planned; but it is possible also on the San Antonio, the Guadalupe, the San Cruces, the Marquis, and even going farther east, on the Colorado. There is some farming land west of Colorado in that section.

STATEMENT OF W. H. STEERUWITZ, STATE GEOLOGIST OF TEXAS.

The CHAIRMAN. What is your occupation?

Mr. STREERUWITZ. I am a civil and mining engineer, and State geologist for western Texas.

The CHAIRMAN. Are you familiar with the topography of western Texas?

Mr. STREERUWITZ. I am as familiar with it as I could make myself within the last ten months and by short trips in former times. I am as familiar with it as any one here.

The CHAIRMAN. Have you during your investigations had your attention called to the possibilities of that country with regard to irrigation?

Mr. STREERUWITZ. Yes; I have for a number of years proposed the building of reservoirs in the mountains, because it struck me that it would be a very easy matter to do it, and probably it would be a great deal cheaper than experimenting with artesian wells. The mountains in some places come together very closely, and, so far as I could ascertain, the bed-rock being very close to the surface, it would form a number of reservoirs to cover say from 10 to 50 square miles.

The CHAIRMAN. What is the rain-fall in that region? Is it sufficient to fill a reservoir in the storm season?

Mr. STREERUWITZ. There are very few rains here; but when they come they come with a will.

Senator REAGAN. Of what portion of Texas are you now speaking?

Mr. STREERUWITZ. Western Texas; west of the Pecos River. So

far as I could ascertain in ten years, the annual rain-fall within a circuit of 100 miles around Fort Davis has averaged 19.9 inches in February. Farther east, where I have my tent at the present time, I have had within the last three months 3¼ inches of rain-fall. That is the result, so far as I could make my observations by crude means.

The CHAIRMAN. Are you acquainted with Texas farther east?

Mr. STREERUWITZ. I know Texas very well. I am a citizen of Texas, and have been for twelve years, traveling around every year.

The CHAIRMAN. What are the particular streams that would furnish water for irrigation if the waters were stored in the mountains above?

Mr. STREERUWITZ. The Colorado River of Texas might; the Llano River partly; the San Saba River; part of the Brazos River; the Pecos River; the Nueces River; the San Antonio River; in fact, you might say any of the rivers of Texas—the larger ones that deserve the name of river. In eastern Texas it is not necessary, because we have more rain there than we need. Of course in western Texas the Rio Grande and Pecos Rivers are of great importance. But between those two rivers we would have to rely on the rain-fall.

The CHAIRMAN. There are no ravines between?

Mr. STREERUWITZ. Yes; but they are in the valleys, and they would not do for reservoirs. We have here between the mountains old lake-beds running down in sand and gravel many hundred feet in some places, so that the reservoirs, according to my idea, would have to be put back in the small valleys between the mountains themselves. There the mountains are close together, and the bed-rock is not more than 10 or 15 feet from the surface. If that were not so it would be expensive, and it would not pay to build them.

The CHAIRMAN. Has the subject of irrigation been discussed in Texas?

Mr. STREERUWITZ. It has been discussed here and on the Pecos more than anywhere else. So far as I know, and from what I see in the newspapers, it is becoming a vital question. There is no doubt that it is one of the live issues for the Rio Grande Valley.

The CHAIRMAN. There is a large amount of land that could be brought under cultivation from the various streams of which you have spoken and the reservoirs that might be built?

Mr. STREERUWITZ. There is a large valley extending, we may say, from Sierra Blanca down to Fort Davis, 10 miles wide, that is nearly as flat at this table, and of good soil. From about a half mile from the mountains it is excellent soil. I made an analysis of about twenty different soils along this valley.

The CHAIRMAN. Then there is a large amount of land containing good soil in western Texas?

Mr. STREERUWITZ. Excellent soil. All it needs is water. It is very good agricultural soil.

Senator REAGAN. Have you examined the country up in the Pan Handle?

Mr. STREERUWITZ. I was up in the Pan Handle, but I made no particular examinations?

Senator REAGAN. Have you made an examination to ascertain whether there are any streams in that section with which you could irrigate?

Mr. STREERUWITZ. The Upper Brazos. Its largest forks, the Salt Fork and the Double Mountain Fork, are hardly fit to irrigate with. One is charged with brine and the other one is too strongly alkali. Then there is Clear Water Fork; but the valleys there are not to be

taken into consideration for irrigation, because the expense of the dams would be too high for the value of the land.

The CHAIRMAN. Have you been through the country to the Indian Territory, to Oklahoma?

Mr. STREERUWITZ. No. I was in Oklahoma for a year, spent the summer in the Chickasaw Nation, making examinations along the Santa Fé Railroad.

The CHAIRMAN. Would they require irrigation there?

Mr. STREERUWITZ. In Paul's Valley they had excellent crops on the Washita River. There is plenty of water there; the Washita River was full of water all summer.

Senator REAGAN. Have you any information about the wells along the plains?

Mr. STREERUWITZ. I have no information about the wells there.

STATEMENT OF SENOR J. ESCOBAR, CONSUL FROM MEXICO AT EL PASO.

The CHAIRMAN. Will you proceed and make any statement you may desire with regard to the effect of using for irrigating purposes the water above here on the Colorado and Rio Grande Rivers? Explain how it affects the people of your country.

Mr. ESCOBAR. I would prefer to answer questions. On that point, however, I will state that we consider our rights come from the first occupancy of the river. Having disposed of those waters for two centuries, we can not now be deprived of their use without injustice being done. I do not think it would be just to conserve all the water as they have done in Colorado and deprive the people of Mexico of it. I do not think it right to give life to a new people and in doing so kill an old people.

The CHAIRMAN About how many persons reside in the valley of the Rio Grande on your side of the line?

Mr. ESCOBAR. In this valley, for some miles, we have no less than 25,000 population.

The CHAIRMAN. And this population is dependent upon this water?

Mr. ESCOBAR. Yes.

The CHAIRMAN. Does it affect them below?

Mr. ESCOBAR. Not so much below. The necessity for the waters ceases at the confluence of those rivers.

The CHAIRMAN. But above that?

Mr. ESCOBAR. To allow the water to be taken out as it is now will be to destroy the people on both sides; because the life of the people is agriculture. They would have to emigrate; they could not live. If you will pass over our side you will immediately see the effect. Our vineyards have decreased one-half, thousands of fruit-trees are barren, and the corn-fields are entirely lost.

The CHAIRMAN. This is an unusually dry season.

Mr. ESCOBAR. It is unusually dry; but it is not only on account of the lack of rain, but it is on account of the deprivation of the water of the river. Such a thing we have never seen before. And it is now exceedingly difficult to make wells, while before this condition of things it was easy to reach water.

The CHAIRMAN. Did you feel its effect before this season?

Mr. ESCOBAR. No, not before this season.

The CHAIRMAN. When you have a more favorable season would not *this difficulty* be removed?

Mr. ESCOBAR. Oh, yes. In the winter we expect to have water. But our crops are already lost.

The CHAIRMAN. What have you to suggest as a means of restoring the water to you?

Mr. ESCOBAR. It seems to me that proper legislation in Colorado and New Mexico could avoid that. Of course, I acknowledge it would be a very difficult thing. But the project that has been presented by Mr. Mills is a satisfactory solution of the local necessities. His project begins by an acknowledgment of our water rights, and distributes the water in such a way that we can not claim more—one-third to the American side, one-third to the Mexican side, and one-third to form the current of the river; which will produce the effect of avoiding that constant change every year which has been the cause of perpetual strife on both sides. We are never at peace, and we can never be at peace so long as this shall be. No matter what may be done on both sides of the river, the question will be continued so long as the river is the boundary line between the two countries. But this proposition solves the difficulty. The changing of the river is the feature that makes this question very interesting. Its adoption will awaken the sympathy of the Mexican Government so soon as an official acknowledgment of it shall be made. It is an excellent project.

Senator REAGAN. For how many years has the Mexican side of the boundary been populated—as far as you know?

Mr. ESCOBAR. Not less than two hundred and seventy years.

Senator REAGAN. What portion of that time have the people been using the water out of the Rio Grande?

Mr. ESCOBAR. There was in the past a population that could not use all the water, because there was an abundance of it.

Senator REAGAN. How long have the people been using the water for irrigation?

Mr. ESCOBAR. From the earliest settlement. The Spaniards crossed first into Mexico, and established a settlement, and the other Indian towns that were established became Mexican. They were the first towns on the border of the river. Ever since that settlement there has been a little dam above the town. It has been renewed yearly. That is the one to which Mr. Bronson alluded. That has been giving water to the Mexican people since that time, plenty of water for irrigation. They opened a big canal sufficient to irrigate all the valley. That canal we have been using for centuries. But now there is not a drop of water in it.

STATEMENT OF MAJOR ANSON MILLS, U. S. ARMY, OF FORT BLISS, NEAR EL PASO.

The CHAIRMAN. We would like to hear any statement you may have to make on the subject of irrigation as applicable to this country.

Major MILLS. I suppose you wish first the general features of the project to build a dam in what is known as the North Pass, about 3 miles above the city, and form a large lake in the valley above. So I will give them.

The valley above extends for 60 miles. It widens gradually, after leaving the Pass going north, and has at some places a width of 4 and at others 12 miles. But what we have to do within our reservoir will only extend 25 miles from the city.

The plan is to build *the dam, say 60* feet high, and at the most favor-

able point in this pass. We have made soundings at various places, and have discovered two suitable locations; one about 1½ miles from the city, and the other about 2½ miles. At the lower place we have one end of the dam in Texas and the other in Mexico. We have another advantage from the fact that we could use the Mexican dam during the construction of the new dam, and lower the water from 8 to 10 feet, and thereby have less trouble in sinking our caissons to build the dam.

Another advantage is that the bed-rock is nearer the surface there, the deepest sounding in the cross-section being 7 feet. The great difficulty in this location comes from the changing of the railroads—the Southern Pacific and the Atchison, Topeka and Santa Fé. The Southern Pacific would have to be changed for about 5 miles in order to keep the track out of the submerged district, and that would be somewhat difficult to do. The grade of the Southern Pacific is 1 per cent., or 52 feet to the mile. That is their maximum. The grade of the Santa Fé is the half of 1 per cent., or 26 feet to the mile, so that in order to rise over this 60 feet of dam from the city, it would be difficult to get the Santa Fé to increase their grade, because they would have to double their engines to get over the dam.

The upper location is preferable on account of the feasibility of climbing the dam by the railroad; also from the fact that it is not so broad. The dam would not be so long, and in that respect would not be so expensive, and yet in regard to bed-rock it would be more expensive.

Now, this elevation of 60 feet would throw the water back in the lake 15 miles from the upper dam and over 16 miles from the lower, the fall of the river being about 4 feet to the mile.

Mr. Follett, a civil engineer with experience in railroads, was employed by Colonel Nettleton to do the platting, and the map before you is his work. The blue line [indicating] describes the lake as it would exist when flooded. The average is 3 miles in width and 15 miles long. It would cover an area of 26,000 acres of land. Of that 26,000 acres, 16,800 acres are in Texas, and all of that but 1,000 acres are patented to individuals. These 1,000 acres are supposed to belong to the city as school lands. That part in Mexico will cover 9,400 acres of unconfirmed Spanish grants, the Refugio colony grant, and the Francisco Garcia grant. There are about 1,000 acres of public land, not covered by either of these grants or claims, in Texas.

To illustrate the difficulty of arriving at the location of the land and of ascertaining to whom it belongs, it should be explained that this river is constantly changing. It is inconstant in its flow and inconstant in its position. The present river is described by this other large blue line [indicating]. There is now a river opening here [indicating], and the next high season will carry the river over the Atchison, Topeka and Santa Fé track. This red line describes that; it represents the preliminary survey.

The CHAIRMAN. This line [indicating the railroad] will have to be removed?

Major MILLS. That is the preliminary survey, made by Mr. Follett up in the bluffs.

The CHAIRMAN. The railroad would have to be changed for 15 miles?

Major MILLS. Yes, in my judgment, it would have to be. So soon as that river opens it would change it anyway. There is no abutment within the range of any railroad company that could protect it.

The CHAIRMAN. Probably that could be changed without any difficulty.

Major MILLS. It would be an expensive change. We shall have

trouble to induce the Atchison, Topeka and Santa Fé Railroad to adopt the new line without compensation from the Government. That road is not now paying the stockholders, and it could not be made to adopt that change without compensation. The Southern Pacific could make the change, and they would get a better grade. This [indicating] is the present Southern Pacific, and this [indicating] to this point is the proposed change for them.

The CHAIRMAN. Have they laws in Texas and Mexico providing for the condemnation of land for reservoirs for the storage of water?

[Mr. HINTON. There are such laws in Texas.]

Major MILLS. I have no knowledge in that respect. The river, at the time some of these surveys were made, ran here [indicating]. I might state that I was appointed to the army from this town, and was previously the surveyor for this district and surveyed all the land from the New Mexican boundary down to El Paso and 75 miles below. At that time this [indicating] was the position of the river. See how it has changed since. I made those surveys in 1858 and 1859.

This land could be easily condemned, and it probably ranges in value from $1 to $7 per acre. The whole expense, therefore, would probably be not over $100,000.

The CHAIRMAN. Outside the railroad changes?

Major MILLS. Outside the railroad. The dam at the upper location indicated would probably cost $200,000. Mr. Follett made an estimate of that last year. He estimates it at $221,000.

This project, I should have explained in the first instance, is for the control of the boundary and the preservation of the lands adjacent to it on each side. And to illustrate how necessary that is, I would like to show you a map that was made by the county surveyor, Mr. Heldt. That shows how changeable the river is, and the various complications that are constantly rising on account of those changes.

As shown by this map, El Paso is situated on the Ponce de Leon tract. Here [indicating] is the pass where the river has a straight line for 3 miles. There [indicating] is the lower Mexican line. The lower dam would be there [indicating], and the upper dam here [indicating]. You will observe that the river leaves the pass. It has always a tortuous course, winding about. This line [indicating] shows where the river was in 1849; this one [indicating] shows where it was in 1858, when I made the surveys down below.

Now, if this dam could be built, it is believed that it would control forever the changes of the river bed, and that it would maintain a constant and invariable flow. So that, if the river is constant and invariable, the sediment will stay in the lake and the water will back clear through, and this boundary will have no changes. To do that a boundary commission would be necessary to cut off this bend, straighten the river, and throw that which would fall on the Texas side of the channel into the jurisdiction of Texas, and that which would fall on the Mexican side into the jurisdiction of Mexico. As it is at the present time, in seasons of high water most of these lands are overflowed. The river makes a sudden turn, and houses are carried into the water. Then comes these dry seasons in cycles of about seven years to dry up and kill new trees and vines, and make it almost impossible to raise anything.

Before the annexation of Texas all this land [indicating] was on the right bank, or Mexican side; but since then it has changed to a deposit on one side, by erosion on the other. Down below here [indicating] it is constantly *changing*. *Here* [indicating] we have a tract of

land of several thousand acres. The river five years ago was running here [indicating] on the east side of it. In that high season it made a sudden change and destroyed the Galveston Railroad, just as will be the case with the Santa Fé some day out on the bluffs.

In order to irrigate their lands the Mexicans had to come on Texas soil. They built a dam on both sides of the river through Texas territory to irrigate their own land. I mention that to show the complications that are rising and will arise every year. Then there are other difficulties that may arise with the collector of customs. With his inspectors he may observe a train packed with goods and may attempt to seize them on account of their being in Mexico, and it will be difficult for any court to determine whether they are in Mexico or not. It is always difficult to convict in criminal cases—cases of arson, murder, or theft. The sheriff on one side may claim that he is without jurisdiction, having no boundary.

Now, if this project had simply the object of irrigation, I could speak with a little more minuteness as to that.

The CHAIRMAN, We wish to know what this dam would accomplish.

Major MILLS. The dam would contain 531,000 acre feet, that is, the whole of the dam. One-third of that, the upper 10 feet, would be available for irrigating purposes, and it would irrigate about 500,000 acres of land.

The CHAIRMAN. On which side of the river?

Major MILLS. On both sides.

The CHAIRMAN. It might be equally divided between the two.

Major MILLS. Yes. Of the new land which would come under the ditches, the Mexicans would have a little the preponderance. The Mexicans would have 125,000 acres that could be brought under the ditches. I dare say it is better to have a ditch only 50 miles long in this arid country where evaporation is so great and the soil loose.

The CHAIRMAN. Are you familiar with points farther up?

Major MILLS. Yes. There is a good site for a dam at Fort Selden, but it is not so good as this of which I have been speaking.

The CHAIRMAN. How far is Fort Selden?

Major MILLS. Sixty miles, I believe. There the site for the lake is contracted, the river bluffs coming together, and you could not impound so much water as in this dam, probably by one-tenth.

The CHAIRMAN. Does the river carry down much silt?

Major MILLS. Probably it does. When I first projected this plan I was told that it would be impracticable, because the silt would fill up the lake.

The CHAIRMAN. Have you made any investigations on that head?

Major MILLS. We have made investigations during the whole of this season, and we found that the average carried was less than one-third of 1 per cent.

The CHAIRMAN. Would you provide for sluicing the dam to clear it of silt?

Major MILLS. I think probably it would be three or four hundred years before this dam would fill up. So that we may leave it to the people. They will have better facilities for sluicing it then.

The CHAIRMAN. If this civilization is not destroyed.

Major MILLS. Yes. That is the view that I take of it. That is an element that need hardly be taken into the present problem.

Now, in regard to the construction of this dam—by whom should it be made—I would like to say this: I do not see how it will be possible

to construct it by private enterprise; and for these reasons: It is international, in the first place, and it would be hard to get a charter from the two Governments that would sufficiently secure the investors in their rights to dividends. In our country it is very feasible, because here they can take a lien on the land for the money invested. In Mexico, however, it is different. The proprietors of this enterprise would necessarily be Americans, and there would be that doubt on the part of Mexico and on the part of the investors that they were fairly dealt with. Then, to control the boundary, I do not see how private individuals could do that.

The CHAIRMAN. Could not the Government sell the 100,000 acres of land that would be brought under cultivation by the dam?

Major MILLS. Yes, that would be true in Mexico; but in the State of Texas, where we own all the land, it would be different. There is in Texas very little vacant land belonging to the Government.

The CHAIRMAN. Could we not sell the water right? Suppose there were 100,000 acres brought under cultivation on the Texas side. That is valueless now; but with water on it it would be valuable, worth from $25 to $100 an acre. Could not the persons who occupy that land well afford to pay something for the water right?

Major MILLS. They would be willing to do it, I dare say.

The CHAIRMAN. On the Mexican side, where they have had water, it would not be fair to charge them; but where they reclaim new land, they might. And on the United States side it would be the same.

Major MILLS. That land would be the best land, according to my experience. Lately I have been in southern California, and I think you will bear me out that around Los Angeles the upper lands are better than the bottom lands because they can be irrigated without overflowing. Then they are not so heavy. So that these new lands would be more valuable than the old lands.

The CHAIRMAN. Would it be practicable for you, after having made the surveys and ascertained who owned the land, to get a proposition from the land owners stating how much they would pay for permanent water rights if the water were brought in by the Government?

Major MILLS. That would be practicable, to some extent. I surveyed 50 acres of land here for Mr. Hamburg, of San Antonio. Now it is owned by Mr. Dodge, of New York City. Mr. Heldt showed me his tax receipts. They were for large tracts of land in Mexico, but he does not know it. General Dodge is probably paying taxes on 75 acres of land over on the other side of the Rio Grande belonging to the Mexicans. This map was finished but a few days ago.

The CHAIRMAN. If the Government should run the water over the dam, you would not let it go out until it was paid for?

Major MILLS. My idea would be for the Government to build the dam, build the reservoir, change the railroad, and provide how that water should be disposed of, and turn it over to a private corporation thereafter. That could be arranged.

The CHAIRMAN. If there are 100,000 acres to be redeemed, the land reclaimed would pay the cost two or three times over at $25 or $30 an acre.

Major MILLS. Mr. Follett tells me that it is impossible for him to get up an estimate to rely on for changing the road. It will cost from $800,000 to $1,000,000 to complete the work, but that is merely a guess; it may not cost $600,000.

The CHAIRMAN. That would be $10 an acre for 100,000 acres?

Major MILLS. Then *the water power* would be there, and the climate,

by the presence of this vast amount of water, would be changed. But that is problematical; we can not tell about that.

The CHAIRMAN. It is not problematical—covering the soil with vegetation would make the climate more healthful, and make the atmosphere more damp.

Major MILLS. I feel a great enthusiasm in the project. I believe it practicable, and I believe the country sufficiently progressive to build a dam, and have no doubt it will be built in the next few years.

Senator REAGAN. What is the fall of the river above this dam, and for some distance up?

Major MILLS. The river generally averages 4 feet to the mile for 50 miles above and below here. Strange to say, there is a greater fall in the valley than there was in the pass. That was a surprise to me. In the rapids the fall is less than where the river takes this turn here.

Senator REAGAN. There are table-lands lying east?

Major MILLS. Yes.

Senator REAGAN. Is there any water above where it could be taken out on that table-land?

Major MILLS. I am not sufficiently posted to state that. I suppose there is, by making a high dam.

Senator REAGAN. How far down below this do you estimate that the channel of the river can be controlled by the construction of this dam?

Major MILLS. I am quite sure if the dam should be constructed with the vast quantity of water that it would hold, the river could, in a degree, be controlled to the Gulf, and absolutely controlled to 100 miles to the cañon regions, because there is no confluence between this and 100 miles down. We would allow so much water to pass through the dam each day.

Senator REAGAN. What is the character of the valley?

Major MILLS. About 75 miles below, a little more—90 miles—below old Fort Quitman, the bluffs come in. These bluffs close in, and there is no valley land there.

Senator REAGAN. How far down does that cañon go?

Major MILLS. That runs down 100 miles.

Senator REAGAN. If you could control the bed of the river down to this cañon, no difficulty would arise. How much of the land that would be covered by the proposed reservoir is cultivated land?

Major MILLS. I do not think there is more than 500 or 600 acres. There is no cultivated land in the whole 26,000 acres that would be submerged, except a little colony called the Liunia. There is a town right there—a settlement—and they have taken out a ditch. The ditch would cover probably 1,000 or 2,000 acres. There are probably only 500 or 1,000 acres under cultivation. That could be condemned, because it is not deemed valuable.

Senator REAGAN. Are there any buildings or valuable structures on it?

Major MILLS. No.

Senator REAGAN. The marks here [pointing] indicate that the land has been taken up.

Major MILLS. It has been all taken up. Here [indicating] is a tract marked "State." That is school land. I think 1,000 acres belong to the State and to a great many individuals living here in the city. I own some myself.

Senator REAGAN. Is there any value fixed to that land?

Major MILLS. No. Some of it is sand-bars that you can not sell at *any price.* The other would be, if this project were carried out, the best

land in the country; but at the present time nobody would settle on it. Something must be done to settle that land below. If you will ride from the city down on this or the other side you will see the trees perishing, and so with the vines; and this will continue to be the case until they have some water.

Senator REAGAN. Is there any current price on this land?

Major MILLS. I do not think there have been any sales in there; I have never heard of any. I have tried to sell mine, 100 acres in this tract [indicating]. I have owned it for thirty years. I tried to sell it, but could not do it. I offer to the committee a memorandum on the general character of the project:

INTERNATIONAL FEATURES—BOUNDARY—THE RIVER JOINT PROPERTY—VESTED RIGHTS IN THE WATER, BY APPROPRIATION TO PRIOR USES.

The lake covers an area of 26,270 acres, 16,830 being in Texas, all but about 1,000 acres (which is supposed to be State school lands) being patented to private parties; all that in New Mexico, 9,440 acres, except about 1,000 acres (which is supposed to be Government land), lies within two unconfirmed Spanish grants, "The Refugio Colony" and "The Francisco Garcia." The lake will be about 15 miles long by about 3 miles wide, and an average of 20 feet deep with a total capacity of 23,160,777,000 cubic feet of water; the capacity of the proposed reservoir of 10 feet on top will be 8,610,565,000 cubic feet.

Of the two proposed sites for the dam, one lies about 2¼ miles from the city and the other about 3¼ or about 1½ miles apart. Relative merits, bed-rock, six outlet gate-valves of 4 feet carry 2,400 feet with 50-foot pressure, and a crest overflow 200 feet long by 4 feet deep will carry 7,400 feet, equal to 10,000 feet, sufficient with the storage to relieve any probable or possible flood from overflowing the dam.

The first measurements of flow were taken on May 20, showing 4,300 feet, and were continued until July 28, when it had been gradually reduced to 29 feet, and river ceased to flow August 5.

Measurements for evaporation have continued since May 10 with an average of about 10 inches per month.

Measurements of sediment continued during the flow since June 10, showing an average of .345 of 1 per cent of the water carried.

Approximate cost of the work.

Condemnation of the lands to be submerged ($100,000); reconstruction of 15 miles of the Santa Fé Railroad; reconstruction of 5 miles of the Southern Pacific Railroad; building of the dam, gate-valves, and waste-weir; approximate total cost of work, $321,000.

The committee here took a recess until 2 o'clock.

The committee re-assembled at 2 o'clock p. m.

FURTHER STATEMENT OF EDGAR B. BRONSON.

Senator Stewart made a statement to me this morning after the meeting of which he desired an explanation. It was with regard to the condition of the arid lands of western Texas. He wishes me to demonstrate the necessity or no for appropriations looking to the investigation of the resources of the country for reservoirs, dams, and that sort of thing.

The CHAIRMAN. We want the facts to show whether it is necessary or not.

Mr. BRONSON. In the region of western Texas, which might, perhaps, be defined by a line drawn north and south, through Colorado City, there are some few mountain chains. But the mountain chain is not a prevailing feature of the country; plains are the prevailing feature. The character of the country is such that the rain-fall is very light. On the mountains, though, it is very great. There are very few of these mountain ranges which *have permanent* streams, yet, in the rainy sea

son, they pour down torrents of water, and there are dams that would afford streams for irrigation. I speak of the great mesas lying to the west of Fort Davis. Along the Southern Pacific there is a mesa 150 to 200 miles long, averaging 30 to 80 miles wide. From the mountain ranges on the west side, in what Major Powell calls the torrential season, there are poured down great bodies of water, and there might be accumulated in reservoirs a sufficient quantity of those waters to irrigate an immense area of land.

The CHAIRMAN. Is that country occupied at all?

Mr. BRONSON. It is sparsely occupied along the railway. There are small settlements and nothing else, because no tillage is possible there. It would require a community of labor and organized capital to make the large reservoirs necessary to irrigate that great country. Apropos of that subject, you go on the plateau of southern Mexico where there is a dense population, where the country is under tillage in cotton and all varieties of crops, and there the conditions are the same as in western Texas. They have no streams, and the rain-fall is inadequate to make irrigation possible; and the result is what—what we are beginning to do here. The whole country is covered. Each has a dam which conserves the water which falls during the rainy season and is held and stored over to the period when cultivation is desired, when it is used in irrigation. I think, perhaps, there are some hundreds of square miles actually under tillage south of the city of Santiago, Mexico, under the system which is now proposed in western Texas. I have seen it, and it is practically here as it is there. The rain-fall of that country is about as it is here. For instance, they take a region of country with a great drainage area behind it, a series of important hills or large range of mountains, and they bring several of the waterways together. The water is then brought down until it reaches a point where it is convenient to make a reservoir, and there they store the same. Those are the conditions of that country. When you get to the Texas Pan-Handle the conditions change from those you see here. There you have no range of mountains; the important ranges are sand hills, which are perfect sieves. But in almost the whole belt, or two-thirds of the Pan-Handle, the water is found 5 to 56 feet deep in an inexhaustible supply, and the system there is pre-eminently a well system. The water lies near the surface, and it is inexpensive to raise it. But the country does not lay in such shape that reservoir irrigation may be practiced to any great extent. There are a few places, such as the head of the Yellow Horse Cañon and Yellow Fork. They begin with long dry ravines, and in those places it might be practicable to make your systems of dam storage. But it has always seemed to me, since I became familiar with Santiago, that the same thing could be practiced here in western Texas, and the country become as rich as any in the United States. I think I am safe in saying that one-third of the cotton raised in the Republic of Mexico is raised under that particular system of irrigation—fully a third of the cotton.

Senator REAGAN. Have you been acquainted with any place that is under cultivation by irrigation in Tom Green County or anywhere else?

Mr. BRONSON. The Comanche Creek section, by Fort Stockton. It is at Fort Davis. That is the only place in western Texas outside of the valley.

Senator REAGAN. Do you know of any one here acquainted with the waters of the Colorado or Tom Green County?

Mr. BRONSON. It is there where irrigation is practiced to any extent. *I understand there is a* gentleman here who is familiar with some parts

of that country, whether the particular parts to which you refer, I do not know. I am not familiar with it.

STATEMENT OF E. E. ROESLER OF DALLAS.

The CHAIRMAN. What is your occupation?

Mr. ROESLER. I am emigration agent for the Texas Pacific Railway, and I am also secretary of the Marienfeld Co-operative Fruit and Garden Irrigation Company.

The CHAIRMAN. Are you familiar with the topography of the country, the character of the land, and the other possibilities for irrigating portions of Texas?

Mr. ROESLER. Yes; I have made a special study of that since 1886.

The CHAIRMAN. In what portions of Texas?

Mr. ROESLER. From the Brazos River almost to El Paso. What is known as the Staked Plains.

The CHAIRMAN. Go on and describe the character of the country, and state what the facilities are for irrigation.

Mr. ROESLER. Beginning at the Brazos River, which is at an altitude of about 900 feet, the country rises in steps toward the west. It is generally in the form of one plateau above another. So you proceed westward from Brazos River 20 or 30 miles, and you come to a bluff 200 or 300 feet in height, and above that is a plateau which extends 20 or 30 miles. The difference in altitude is from 150 to 300 feet in these plateaus. From west of the Colorado River the rain-fall is from 20 to 46 inches, with an average of 26, and in that country it has not been found necessary to irrigate, although it is found advisable with the garden crops, vegetables, and things of that description. They have been benefited by irrigation. On the Concho near San Angela there are about 5,000 acres under cultivation by irrigation, and all the waters are obtained from the North and Middle Concho Rivers. About 50 miles north of San Angela that river springs out of the ground. Above that there is no river, but simply an old river-bed that extends all of 300 miles across the country into New Mexico. In the north branch of the Concho River, which is known where it crosses the Texas Pacific Railroad as the Mustang, irrigation is considered necessary. We have an extraordinary farming section there, and we found since 1882 about the following:

In 1882 there was abundant rain-fall, and wheat made from 18 to 25 bushels; corn ran about 30 bushels, and the small grains between 18 and 20 bushels. Vegetables of all sorts did well. In 1883 the crop was equally good. In 1884 they made about a half crop. This was all without irrigation. In 1885 there was an extra good crop. In 1886 there was a total failure. They planted all the seed wheat they had, put it in the ground five times, and lost every bit. In 1887 the failure was as great as in 1886. The result was that everybody became discouraged, and those who had money enough to leave the country left it; those who had not, staid. They then began to bore wells. In Martin, Howard, and Andrews Counties the farm land was increased in capacity to five or six times what it had formerly been. People bought wind-mills and erected small dirt tanks and went into fruit-raising. The result in the matter of fruit-raising has been very satisfactory. They find that every variety of grape that is grown in California will succeed there. They produce a raisin grape at least six weeks earlier than

it can be produced in California, and every ranch in that section of the country is going into fruit-raising.

I had a number of notes ready for the committee, but I did not expect it for ten days to come. I got a telegram 30 miles off from my home.

The CHAIRMAN. You may describe from memory, and you can report more fully to the committee subsequently.

Mr. ROESLER. On the Colorado River, west as far as the Pecos, there are a few places where we can make dams, but in the balance of it you will have to rely on wells. Then on the Pecos River there is the Pioneer Company's ditch, which is now about 10 miles long, some 40 feet across the bottom, and they have gotten in operation this year. They are still building on the lower end. They have places under cultivation—three or four sections of land. They claim that that river is always running full; that it stays at a certain point and never becomes less. South of the Pecos is Toyeh Creek. That is an old settled portion of Rains County. That has been in cultivation for the last ten or fifteen years, and is irrigated from the waters of that creek. They say there are about 15,000 acres in cultivation there.

Senator REAGAN. What do you know about the wells up there?

Mr. ROESLER. The wells I have examined, a considerable number of them, and I find in Martin County the water consists of two strata. That which is found above the limestone is usually found at a depth of from 10 to 25 feet; it is not lasting, however, for it comes from the local rains. Then from below the limestone, which is usually from 40 to 60 feet, they get an abundant supply, which is not affected by drought or local rains. During the drought of 1886 and 1887 neither of them were dry. The local theory is that all these wells are fed from underground rivers; that the strata from which this water is derived falls from New Mexico, underneath the Staked Plains, and eventually emerge on the Guadalupe and Concho, and one hundred other streams that burst suddenly out of the ground and become rivers without headwaters. The San Pedro, San Antonia, Concho, and many streams in Southern Texas will all appear where the limestone ridge is broken. We hold that between the Pecos and Colorado Rivers the strata are entirely unbroken; that there is a ledge extending for hundreds of miles which is without fraction, and that the water enters it east of the Pecos, and there it is broken by the mountains of El Paso and Reeves Counties and the eastern part of New Mexico. Underneath that flows an immense body of water which again appears after it gets underneath this limestone ledge, where it is broken. It is lying about 200 miles north of the Gulf coast, and makes a semi-circle.

Senator REAGAN. Is there a flowing well at Washburn?

Mr. ROESLER. I understand there are four or five on a ranch there.

Senator REAGAN. Would that be in harmony with the theory just presented?

Mr. ROESLER. I think they are dependent on local causes alone. I spoke with a gentleman the other day who told me that he thought that the supply was gotten a few miles distant; that it was not a part of the general system, but simply some elevated valley that gathered the water and let it out a few miles below.

Senator REAGAN. Do you know the depth of those flowing wells?

Mr. ROESLER. One 60 feet, another 75 feet, and another 110 feet.

Senator REAGAN. Is not the one at Washburn 300 or 400 feet in depth?

Mr. ROESLER. I do not know. That is a recent discovery if it is *there, and I have not* learned of it. I am more acquainted a 100 miles *south of the Texas Pacific* road than I am north.

The CHAIRMAN. Whether you testify again or not you will write out your report and submit it to the committee.

Mr. ROESLER. Yes, I prepared one, and I did not expect you so soon. The news caught me 300 miles from home.

If a suggestion is in order I would like to make one to this effect, that on the part of the Government stations be established, say every 100 or 150 miles, in which there shall be a crew well supplied with a dynamite drill and strong pumping machinery, and that there examinations be made of the soil by boring ten or fifteen wells in a straight line, varying in distance from say 25 to 100 yards. Wherever a piece of land is found 10 or 20 miles in width and 30 or 40 miles in length, with the characteristics uniform, then make a test. After ten wells shall have been bored, put in a steam pump that is capable of pumping 20,000,000 to 40,000,000 gallons of water. Then measure and ascertain the most distant point from the center well which is not attracted by the well, that is, in this way. If you pump the center well dry the next well nearer to it will show a diminution of water, the one a little more distant will also show a little less diminution, and the most distant will show no diminution at all. Then in a radius of 250 or 300 feet, say, you can calculate the amount of water you can get out of a certain radius, and thus know how much water you have in every acre of land in a given distance.

The CHAIRMAN. Would it be expensive?

Mr. ROESLER. I think it will cost money.

The CHAIRMAN. Would it pay to do it?

Mr. ROESLER. It certainly would.

The CHAIRMAN. Have you fuel convenient?

Mr. ROESLER. We have mesquite wood, which will burn out a boiler as quickly as coal.

The object to be gained by such experiments is this: If a man wishes to irrigate on the Staked Plain now, he will have first to get a well, then a windmill, and then a tank, and the whole thing will cost him $400. The entire capacity of this well, at a cost of $400, will be 5 acres, and you will find that he would be paying from $50 to $60 an acre to get water. If the Government will make this test, and say that under a certain area of land so much water can be had, the man who wants to make this improvement can interest others, and instead of getting a little Jim Crow well and windmill, he will get a strong company who will build large tanks to furnish that water for $15 an acre, whereas a single individual could not do it for $75. One section of land in the vicinity of Midlands, as nearly as I can figure out, taking the wells that I know to be there, cost $16,800 to raise enough water and store it to give to each and every acre of that section 24 inches of water during the year. That means 2 inches each month on a dead level.

The CHAIRMAN. That would be more than you would need, would it not?

Mr. ROESLER. Well, perhaps so.

The CHAIRMAN. A foot is about the limit.

Mr. ROESLER. It will depend on the rain-fall. Take it on our irrigated tract, this year we have not used a drop of water. Had we planted in 1886 we would have lost every stalk we had on it. The rain-fall we had then did not exceed 18 inches, according to the rain-gauge. It looks as if that country were well supplied with water, but at the time the crop needs it it does not get it. After the crop has failed, there will come a 10 or 15 inch rain and drown out the country. Then a farmer has a new *crop in. I am* satisfied that all that country be-

tween the Colorado and Pecos Rivers, with 15 inches of water on it, will make a crop every year. There is a critical moment, and when that moment comes, if you give the crop water, it will be good.

STATEMENT OF C. I. GARFIAS, OF THE CITY OF MEXICO.

The CHAIRMAN. What is your occupation?

Mr. GARFIAS. I am a civil engineer. I have been sent here by the Mexican department of public works to attend to the public work in the frontier.

The CHAIRMAN. Have you given attention to the proposed dam and reservoir on the Rio Grande?

Mr. GARFIAS. Yes. As soon as the Mexican Government was made acquainted with the fact that Major Mills was here, and that he was going to begin his preliminary work for the completion of his project, I received an order to assist him in every respect. And afterward, so soon as it was needed, to make a survey of the land that would be irrigated, I received an appointment to make the surveys of those lands and to make the location of the canal. So that the Mexican Government is perfectly acquainted with Major Mills's project, and is interested in its completion, and thinks it would be a perfect success.

The CHAIRMAN. What extent of country has been irrigated on the Mexican side?

Mr. GARFIAS. I am not acquainted with those facts. I am only beginning those works, waiting for another engineer who comes from the State of Mexico with instructions.

The CHAIRMAN. Have you run any lines to determine the new works?

Mr. GARFIAS. Not yet. I was appointed only a few days ago.

The CHAIRMAN. The Mexican Government is very much interested, you say?

Mr. GARFIAS. Yes.

The CHAIRMAN. And so are the people?

Mr. GARFIAS. Yes. I want to state that so soon as the American people on this side appointed a committee for this question the Mexicans also appointed a committee. All the members were here this morning; now there are three here; I am the secretary. The president does not talk English.

The CHAIRMAN. As an engineer do you think the plan which has been adopted and presented here this morning the right plan?

Mr. GARFIAS. I think so. The thing is that that location would be much better. The location has one end in Mexican territory and one in Texas. The irrigation canals for Mexico would all be in Mexican territory, and so it would not be required to run that water across New Mexico.

STATEMENT OF THOMAS H. LOGAN, U. S. ARMY, COMMANDING AT FORT HANCOCK, ON THE RIO GRANDE.

The CHAIRMAN. Have you looked over this region, having in mind the possibility of irrigating it?

Mr. LOGAN. Yes, very closely.

The CHAIRMAN. State your observations and your views of the question.

Mr. LOGAN. In the first place, the country needs water very badly. *If we had plenty* of water we could raise anything that will grow in any

other place. That is the result of my observation. And as to the means for getting the water, I think that Major Mills's plan is a very good one.

The CHAIRMAN. For this locality?

Mr. LOGAN. Yes. I do not know anything about the country except from here down to Fort Quitman, 80 miles. There will be about 300 square miles on both sides of the river that will be under the ditch; that is, 150 on this side, perhaps, and 150 on the other side. The dam is simply a matter of dollars and cents to build it. The dam is practicable; it is a small dam in comparison with some I am familiar with. I mean to say the contemplated dams. There are dams that I know of three hundred years old that have been in operation right straight along for three hundred years. One of them is in Spain that was built in 1686, and I think it is in operation to-day. That dam is 110 feet high and, I think, about 750 feet long. It is a masonry dam, built for the purpose of supplying several Spanish towns with water and for irrigation.

The CHAIRMAN. It occurred to me while Major Mills was testifying, though I did not call his attention to it, that it is desirable, if possible, to build this dam higher than 60 feet.

Mr. LOGAN. It is simply a matter of dollars and cents.

The CHAIRMAN. It involves the difficulty of getting right of way from the railroad.

Mr. LOGAN. The Croton Works in New York are 210 feet high. So far as building the dam is concerned, it is simply a matter of dollars and cents and good engineering. I do not know what the local features are on this side and at the foundation, but no matter what they are it can be surrounded with proper precautions.

The CHAIRMAN. You can get a rock bottom.

Mr. LOGAN. There was a French dam built in Algiers right on a rock. There are no engineering difficulties at all. There has been some doubt expressed by a good many people in this locality about the dam filling up. That is all fol de rol. It will fill up, but it can be cleaned out. That dam in Spain, which was built three hundred years ago, is cleaned out every three or four years. It had not been cleaned out before 1884 for fourteen years, and the sediment had increased 75 feet. At that time it was cleaned out in four days at an expense of $150, because they had the appliances to do it.

The CHAIRMAN. Have you seen that dam?

Mr. LOGAN. I have not seen the dam, but I have books on the matter. They have scouring galleries.

The CHAIRMAN. Describe them off-hand. We can get the books afterward.

Mr. LOGAN. Of course the number of galleries depends on the width of the reservoir, and the amount of filth that will be deposited in a given time. That will have to be regulated by observation and experiment. They build near the bottom of the dam, leaving a hole—that is a good plan—something in shape like a wedge, on the upper stream side. They have that closed with gates, and when they want to clean out the dam they raise these gates. At times the silt has deposited so far above the gates that the water would not run. Then by means of a bit with augers they perforated a hole in the dam, and this up-stream side threw the silt right out. They cleaned out that dam of a deposit of fourteen years in four days, and at an expense of $150. The bulkhead was made out of timber. They send men in the lower side of the dam who take augers and bore holes in the timber so as to weaken it, and when they got *enough holes in* there they run away. On the

occasion to which I refer it did not start until two days after they thought they had enough. They ran away because it was a dangerous place to be. After a while it burst out and, as I said, it was cleaned out in four days.

The CHAIRMAN. They left a hole there?

Mr. LOGAN. Yes, sir; they left it in the face of the dam. They are left at proper intervals. Of course they are built strongly and then closed by gates. There is a French dam that has gates that go down with proper appliances for raising them, and a child ten years old can raise them without difficulty, because they have the proper machinery. They do not appear to be necessary in this dam with the pressure of water. Forty or 50 or 60 feet of water has an enormous pressure. It generates such an immense current away above the dam, and gets swifter as it gets lower toward the bottom. There have been no difficulties in the dams that I have read about; that is to say, difficulties in cleaning them out. This dam was in a gorge of the mountains, with a fall of 15 feet to the mile, and the deposit was much more than would be in this river. I have kept a little record at Hancock of the volume of water that flows down this river, and it is enormous. This river runs fifty-eight days in July and August at an average depth of 7 feet and 250 feet wide. Now it is dusty, you know, and there is not a drop of water in the running river except in the hills. I had some difficulty in supplying the post with water. I have a little well dug on the river bank some 18 feet deep, and in it is an abundant supply of good water. The stuff that can be raised down there with a little bit of water is perfectly prodigious. I had some experience in Montana. Fort Keogh, Miles City, was my stamping ground. The same rule applies there as down here. If you can get plenty of water you can raise plenty of stuff. This country on both sides of the river presents less difficulty for a canal or ditch than any country that I have ever been in where they have ditches. There is no work at all except with a spade and shovel. There are places between here and Fort Hancock, 55 miles away, that would not require more than a mile of fluming, and in some places there would not be that much. There are some places where, in crossing ravines, it would be necessary to flume to protect the canal. I have had some talk with the Mexicans on the other side of the river. There, at Paso del Norte and Guadalupe and Fort Hancock, they are very much interested in the scheme. They wanted to know if I thought it would go.

STATEMENT OF J. F. CROSBY, OF EL PASO.

The CHAIRMAN. You know the subject under consideration, and you may go on and make your statement.

Mr. CROSBY. I have been very familiar with this question since the year 1852, when I first came to this country. I think I am somewhat advised of its importance, I may say its vitality, to the interests of this country.

The CHAIRMAN. Go on and make any statement you wish touching what you have observed, the water supply, the land to be irrigated, and the general conditions of western Texas.

Mr. CROSBY. I will endeavor to condense my statement as far as practicable under the circumstances. This country, going back to its historical record for upwards of three hundred years, is well known here. This country, on the other side of the river especially, has had *the use of the waters* of the Rio Grande for three centuries past. I

came here first in 1852, and at that period there was an abundance of water on both sides of the river. In lieu of the dam that has been built since, almost entirely by the expenditure of money by our friends on the other side of the river, either local or by municipal governments, we have had nothing but brush dams. The waters of the Rio Grade afforded most abundant irrigation for all the valley on the other side of the river than was then or has since been in cultivation.

I would like to make one statement here which may perhaps strike you as a little astonishing, because you are familiar with these things. But Judge Reagan comes from a country where they have a surplus of rain and water. You come from a country where the conditions exist about as, I understand, they do here. I wish to state that I have seen the waters of Rio Grande like this. You have been at the Grand Central Hotel. Right opposite there stands an ash tree, in front of Mr. Prudenthal's store, and there was a volume of water that ran along there in 1852 to 1860, sufficient to start the grist-mill that did the grinding for almost the entire country around here. I understand that is 20 feet above the level of the river where it is to-day. And that irrigation and water power was accomplished at least 20 feet. I say in altitude above where the river stands now. Since the changes in the river, the withdrawal of the waters above, the withdrawal of those currents, the people have been forced to go down to the river bed with their irrigating canals until they have gotten down on a level with the river, and have a dry irrigating canal to-day, as our friends on the other side of the river have. There was no trouble then to get water for purposes of irrigation and water enough for all manufacturing purposes in this country. When you take the elevation of a canal of that kind necessary to run a mill to grind 200 or 300 bushels of corn a day, you can imagine what the force of the river was at that time.

But these things have changed from time to time until to-day we are left with a dry river. We have not even water-power here to run the mills, and we have not even power to nourish, invigorate, and foster the plants that we put into the country, and on this and the other side of the river the crop of corn, beans, and all those material products which afford a sustenance to the people are all lost. The question is as to what way this scarcity of water is to be ascribed. I believe it is to be ascribed to the fact that the waters of the Rio Grande, which in prior times ran down this valley, have been diverted. Human nature is human nature the world over, and the people who have settled on the Rio Grande, in Colorado want the water, and they take it and use it to the fullest extent to supply their necessities in the way of making their annual crops.

Then, I am told that there are laws on the statute books, both in Colorado and New Mexico, probably passed over a quarter of a century since. Those laws are very good laws. I have no doubt they are very well framed. They are couched in the language which a lawyer would use. But the question is as to the observance of those laws. I have been living in this country since 1852. I am satisfied that I can state here, as they state under oath, that the waste of water in this river for the last eighteen or twenty years has been sufficient to irrigate from four to ten times as much land as is now proposed to be irrigated, or as is now planted in this valley. We can not control those things; the question is how to do it. The only question with me is how to allow the people of Colorado to get the water they need. They are bound to use this water, just as a hungry man would eat bread or meat. A man in Colorado is not *going to allow it to* pass his field if his crops require

it. He is going to take it. He will not care for the laws on the statute books. And when he has used the water he is happy.

In the valley of the Rio Grande, between here and Socorro, just 200 miles distant, I have seen lakes from 1 to 4 miles in width and 3 to 5 miles in length which I have forded on horseback up to my saddle's girth. All that water came out of the Rio Grande.

The CHAIRMAN. Do the irrigators take it out?

Mr. CROSBY. Yes.

The CHAIRMAN. And it is wasted?

Mr. CROSBY. Yes; that is about it.

The CHAIRMAN. That is criminal.

Mr. CROSBY. The laws are against it. The question with me is how is that to be avoided. I believe if we had a dam here, that is, either at this or some other point on the Rio Grande (I have no interest in either), the whole of that difficulty would be avoided. I am satisfied there is a volume of water that courses down the channel of the Rio Grande from the 15th of May until the 15th of August, taking year in and year out, to irrigate ten times the amout of land that we expect to irrigate to-day. Mr. Bronson stated to-day in his testimony that he conceived there was about 75,000 acres of land in the county of El Paso that could be irrigated successfully by the building of such a dam as is proposed by Major Mills and others interested in this project. He made a hasty calculation. I think he very greatly underestimated the extent of territory that could be irrigated.

Mr. BRONSON. That had no reference to the county, but to the valley proper.

Mr. CROSBY. I am speaking of the valley proper. I now propose to refer to the valley proper. The valley from here to Fort Quitman, without following the meanderings of the river, but where you could run the shortest road, to the end of this valley is 92 miles. That valley has a width of fully an average of 3 miles. Then, I assume that with a dam such as is proposed here you could add to that valley, conservatively speaking, 3 miles more; that is doubling the extent. You put 4,500 acres in rough to the lake, 3 miles to the lake, and it gives about thirty-one lakes to Fort Quitman. Then you double that by the mesa and lower ground which could be irrigated outside of this valley, and you double that proportion, and my figuring is that that there would be over 320,000 acres of land that is susceptible of cultivation in El Paso County alone. A 20-foot dam would flow water over that much land; but with a 60-foot dam you would get it to the opposite side of the river, and you would double that amount; and what is to their benefit on the other side of the river, experience shows us, in a commercial way, is to our benefit. We buy their grapes, pears, apples, peaches, corn; we trade with them in every respect; and you may say that the valley of the Rio Grande opposite us is practically of as much commercial benefit to the town of El Paso as though it were on this side of the river.

And there is one other point to which I wish to refer. If you will measure from Fort Selden to this point, the distance is 90 miles. According to actual measurement, the fall of the Rio Grande River in that 90 miles is 240 feet. Major Mills stated to-day that the fall was an average of 4 feet to the mile. We have here the actual measurement, because the discussion here has led to a consideration of a dam at Fort Selden, 90 miles above this, in New Mexico, or here in the city of El Paso; and hence we have obtained, or endeavored to obtain, all the *data, scientific and* otherwise, in reference to the current of the Rio

Grande River. The fall of the river in that 90 miles, from Fort Selden to El Paso, I understand from Major Mills and other engineers who have made the observations, is 240 feet. Now, with 240 feet of fall in 90 miles, in the flood time, when we have this immense flood—because it is not infrequent that we see this river a mile wide from the 15th of May to the last of August—the volume of water that comes down is ordinarily something surprising. It is an immense volume of water. If you could confine that water with a 240-foot fall you would not only benefit the agricultural interests of the country, but it strikes me you would obtain here and below and above in New Mexico a water-power that would be sufficient for almost any manufacturing purpose which water can subserve. You obtain an immense water-power, just as I stated about this little mill that ran day and night. These gentlemen, some of them, perhaps, in their boyhood have seen that mill run every day and night 20 feet above the river, and when we have any water it runs to-day. How much that can be improved by these scientific gentlemen, Major Powell and Major Mills, I do not know. The good of this country, the interest of the General Government, the amount of wealth that such a dam would contribute, not to the State of Texas alone, but to the General Government, in the way of taxes, would be enormous. It is almost beyond calculation.

Now, I wish to go back, if you will pardon me, to defend in a way our friends on the other side of the river. I make this broad statement: In 1848 the Government of the United States, under the treaty signed at Guadalupe Hidalgo, agreed upon the Rio Grande as a boundary line between the two Governments. What did that mean? Did it not mean that the two Governments should maintain that boundary line, that the two Governments, the United States and Mexico, were permitted to cultivate those lands; that they were permitted under the guaranties of this Government to cultivate that land up to the boundary-line? Both of the Governments have acknowledged it up to two years ago. At that time the Mexican Government made a large expenditure, as you will see, for the works on the other side of the river. To avoid the difficulties that were to ensue from this treacherous stream, this changeful current, they appropriated a great amount of money, and the people on the other side of the river have been taxed for works that have been established there by engineers of the Mexican Government. I do not know the amount of money appropriated, but it has been a large amount. They had been admonished that it was necessary to protect their banks. The United States has not expended anything to protect this side of the river. Land here in front of us on the other side of the river and in this town, by reason of the increased population of the two cities, has largely increased in value. Hence, the Mexican Government has sought to protect their banks of the river because of the change of the river. You will find that the homes over there of poor, indigent people have been swept away, first on one side and then on the other, by the currents of this river. That question is not pertinent to this committee, but I believe that morally and justly and equitably the Government of the United States, a great and grand and rich Government, should say to Mexico that "we gave you an international boundary, we are bound to maintain that; we have neglected to maintain it; you have begun to maintain it, and we should adopt all means in our power to bring that boundary where it belongs." I believe this dam would settle it, and I believe you could let it into your dam 30 feet or 50 feet wide, of clear water; no erosion to increase or decrease on one bank or the other, but you could follow it *down with an* expense far less than can be conceived

of by those who speak lightly of the subject. I believe the thing could be done. I believe we can establish a boundary to-day that would be lasting.

Let us say that an offense was committed over there—murder, robbery, smuggling, or anything of the kind. You do not know where to fix the jurisdiction. We can not do it. Our courts are bothered to know where to fix the jurisdiction. But with this dam, and with a very slight work because there will be no rush of water; there will be only so much water run into that river—you could keep its channel according to the treaty of Guadalupe Hidalgo; and then the work on each side of the river to confine that water to its proper course would be a matter of very small import.

Of course, there are a great many other views of this matter. My judgment is that both the Governments are responsible to their people for all the changes that have occurred in the course of this river, just as if you had an artificial line across the plains from here to Fort Yuma and that were removed. I think these people should be indemnified for the loss of their land by the boundaries of that river. We should come up to the treaty.

I do not know that I should say anything more.

STATEMENT OF E. PROVENCIO, MAYOR OF PASO DEL NORTE.

(Interpreted by Juan S. Hart.)

Senator REAGAN. Will you inform the committee about the decadence of irrigation or loss of irrigation on the other side of the river within your remembrance?

Mr. PROVENCIO. Some twenty years past, during which time my observation has extended, and up to date, there has been a loss of no less than one-third of the territory which was originally irrigated by the waters of the river; to which I attribute, as the principal cause, the lack of water each succeeding year; and I attribute this lack of water to the fact of increased irrigating facilities that have been established in the upper portions of the valley of the river. On this account a large portion of the population of what was formerly known as Paso del Norte, and is now called the City of Juarez, has been of necessity forced to emigrate to distant parts to find support. These emigrants have formed in a great measure the new and thriving towns of La Union, La Mesa, Chamberino, Las Amoles, Nombre, and De Dios, in New Mexico, and along the borders of the Rio Grande, and also the additions in population that have been made to La Massila and Las Cruces. They have increased in population by reason of this emigration.

The parts on the Mexican side of the river that have suffered the greatest loss of population are Seni Cu, El Real, De San Lorenzo, and Tres Jacales; and in the very best inhabited portions of others of our border towns on the Mexican side it is noticed that a considerable portion of the population has left the larger towns.

The principal source of water, the irrigation canal that we had during the past twelve years, our main canal, which was formerly of a breadth of 12 feet and contained 6 feet of water in depth, now has less than 3, preserving its same width. There has been lost during that length of time the greater part of our crops on account of the lack of water. Four mills which have existed along that canal with a water-

power are to-day without any means of turning their machinery. The mills are by name, first, Montoya's, Vicente Provencio's, Jose Caribal's, and Juan Gila's. Their doors are now closed entirely, without doing any work for the past three years.

Senator REAGAN. What amount of water comes down in flood time?

Mr. PROVENCIO. It is an immense quantity that comes.

Senator REAGAN. You have been mayor of Paso del Norte for how long?

Mr. PROVENCIO. I have been two years mayor of Paso del Norte, and for over six years a member of the local council.

Senator REAGAN. What steps have been taken by the Mexican authorities to protect the banks of the river on that side?

Mr. PROVENCIO. The work that was done in former years was almost useless. Very recently our Federal Government has ordered the banks of the river protected by such works as are now subject to your inspection at any moment on the river banks on the other side. I want to make known the fact, which no one can deny, that during the past six or eight years the water which they have had on our side has been hardly sufficient for the land which has been open for irrigation purposes. Prior to that time they had an abundance of water, which has been failing in quantity each succeeding year. I wish to have that impressed on the committee.

The CHAIRMAN. How much land was formerly under cultivation on the other side of the river from this point down to Quitman?

Mr. PROVENCIO. I would place the estimate at 125,000 acres.

The CHAIRMAN. How much is now under cultivation?

Mr. PROVENCIO. Hardly 70,000 now.

The CHAIRMAN. And is the amount gradually decreasing?

Mr. PROVENCIO. It is gradually decreasing. It is about three years ago that, at the expense of the municipality on the Mexican side, there was built just above the city a dam across the river of masonry work which cost about $40,000, thinking that even the shortage of the water, possibly, with such a dam, which was never necessary before, might have been stopped, and they would have a sufficiency of water; but that project has not given good results.

The CHAIRMAN. Is there apprehension that irrigation on the upper portion of the river will destroy it on the lower portion?

Mr. PROVENCIO. Undoubtedly. I cannot attribute the present scarcity of the water to any other reason.

The CHAIRMAN. And the more irrigation they have above, the less water they will have below?

Mr. PROVENCIO. Surely. Every new canal taken from the river above deprives us here of a certain amount of water. Besides I want to make it known to this committee that we have always lived in perfect harmony with the American side of the river. It is true we have established and maintained a dam across the river above the city, but we have always distributed the water in perfect proportions between the two sides of the river, and for that reason, for the fair treatment of the American people, we desire to be treated fairly on the opposite side of the river, and we desire to be given our share of the waters of the Rio Grande.

STATEMENT OF JOSEPH MAGOFFIN, OF EL PASO.

Senator REAGAN. How long have you resided in El Paso?

Mr. MAGOFFIN. I came here in 1844 and I have resided here since 1856.

Senator REAGAN. You have heard the course of examination. Will you state any facts in relation to the sources of water, the means of obtaining water, and the necessity for irrigation here, which you think would be of interest to the committee?

Mr. MAGOFFIN. Prior to 1861—I will go back—the population of Paso del Norte (city of Jaurez) was about 30,000. It was a thriving little city, and also the surrounding country was cultivated. They had no trouble from water, except in exceptional years. Probably once in ten or fifteen years the river would be cut off. During our interstate troubles here and the war of Maximilian, the dam above here was carried away by the flood, and a great many people on the other side of the river left, they being more interested in keeping their country intact than in looking after the dam. In 1868, when I returned here to El Paso, the dam that had been swept away had not been rebuilt. A year or so afterward the dam was again built, and the people who had left El Paso proper and all the farmers commenced to return to their homes and to cultivate the lands. They now have, on account of the scarcity of water and the difficulties that they have been having for the last two or three years in the scarcity of water, commenced to leave their part of the country and go above into New Mexico, Las Cruces, and elsewhere, where they have friends and relatives, seeking new homes. This state of things, it is regarded by not only the Mexican people but ourselves here in El Paso, is caused by our friends in Colorado and New Mexico taking out these vast ditches from the river. The water has lessened from year to year until this year we have none at all.

Senator REAGAN. Does that apply to both sides of the river?

Mr. MAGOFFIN. Yes.

Senator REAGAN. And are the people suffering in Paso del Norte as they are here?

Mr. MAGOFFIN. Equally so. There is no water on the other side of the river. The river was dry this year about the 1st of July, something that never occurred in the history of the country.

Senator REAGAN. What is the usual season of flood?

Mr. MAGOFFIN. The river never fails to rise here the 1st of May, and it keeps up continuously, so that no one can cross it until about the 25th day of July—I mean on horseback.

Senator REAGAN. Did you have any rise the 1st of May this year?

Mr. MAGOFFIN. Yes, we had plenty of water all of April, May, June, and you may say until the 1st of July. The river went dry about the 15th of that month. We had a full river before all the time. I think we had more water in the river than flows in any stream in Texas, Colorado, or anywhere else.

Senator REAGAN. Make any additional statement that you may desire.

Mr. MAGOFFIN. I do not know that I can say anything more than this, that our Mexican friends look upon our Government as a great Government, and are willing to restore these water rights to them. They are now moving in that matter with their government. They look upon it as a matter of justice to them that our Government should *in some way* restore their ancient rights to this water. It is a question

of vital interest to them, as well as it is to the people on this side of the river. And there is nothing that I can see now that will give us this water except the establishment of that reservoir that Mr. Mills contemplates building. In building that reservoir it will cease all complications with regard to the boundary line which has destroyed thousands and thousands of dollars worth of property on both sides of the river. The water will be stored in such a way as not to come down in flood times and wash away the banks of the river. It washed away at Fort Bliss and destroyed my father's property there, worth $100,000, and has destroyed other property equally valuable on the other side. Sixty-five miles from here is Fort Selden.

Senator REAGAN. Up the river.

Mr. MAGOFFIN. Yes; they contemplate building a dam there for the purpose of irrigating all the land west of us here, in New Mexico. That will again take the water away from this section of the country; and if something is not done by our Government I do not see what the people below here are going to do. We can not do this work as a people, because the international questions come in that will interfere with private capital engaging in the enterprise. They are questions to be settled with Mexico amicably, and adjusted so that they may get their water rights. No one has a right to question or look into that question but our General Government, and we have our hands tied here expecting that you gentlemen will try to help us out of the fix.

STATEMENT OF W. W. FOLLETT, OF THE GEOLOGICAL SURVEY.

The CHAIRMAN. What is your occupation?

Mr. FOLLETT. Engineer.

The CHAIRMAN. In the employment of what?

Mr. FOLLETT. Temporarily in the Geological Survey.

The CHAIRMAN. You have been making surveys in this country?

Mr. FOLLETT. I made the survey for the lake and these maps that have been presented. I made that above the town; the one below was made by the county surveyor, Mr. Heldt; but the survey above the reservoir I made.

The CHAIRMAN. Have you given any attention to the subject of irrigation?

Mr. FOLLETT. I am from Denver down here for the purpose of making these surveys; was never in this country before.

The CHAIRMAN. Would it be practicable to build that dam higher?

Mr. FOLLETT. Yes, 10 feet higher.

The CHAIRMAN. In building it 10 feet higher to what extent would it flood back on the land?

Mr. FOLLETT. The principle amount it would cover would be directly in the river bottom, which, at the upper end, is 3½ miles wide, practically 2½ miles, covering 8 square miles more than now covered.

The CHAIRMAN. Would it injure much more property?

Mr. FOLLETT. It would only a short distance above the head of the lake as now surveyed. I do not know how far, but I think only 4 or 5 miles. There is a town they call Montagu where there are vineyards, and it would flood those, and that is very valuable property.

The CHAIRMAN. Valuable, compared with what it would now cover?

Mr. FOLLETT. Yes.

The CHAIRMAN. About how valuable would it be, too much to allow you to build *the dam 10 feet higher*?

Mr. FOLLETT. Ten feet more would add about 40 per cent. to its present contents.

The CHAIRMAN. If they have the amount of land that they say they have, and there is a chance to fill it, it seems to me there is no difficulty about it.

Mr. FOLLETT. The estimates that Mr. Heldt made on this side of the river from Faben's to Fort Hancock is 36,000 acres that it will cover, and there are probably 10,000 or 15,000 above that, making 50,000 acres on the American side.

The CHAIRMAN. Have you investigated to any extent the probabilities of filling such a reservoir?

Mr. FOLLETT. I have investigated the probabilities of filling this particular one.

The CHAIRMAN. Do you think it could be filled?

Mr. FOLLETT. Yes; it could be. The general flow of the river, allowing a reasonable amount to pass the dam, would probably fill it, the first filling, in the course of two years. Of course, a great deal would soak up. It is hard to say how much would be taken up; but it is safe to say that it would be filled in two years, or two and a half after it is built. In July it was carrying 600 or 800 cubic feet per second.

STATEMENT OF J. W. EUBANK, OF EL PASO.

The CHAIRMAN. You have been county surveyor. What do you say as to the amount of land that could be covered by a dam 60 feet high for purposes of irrigation?

Mr. EUBANK. I have made a calculation of the land in the low part of the valley, from here to Quitman, and I calculated that it was about 110,000 acres. But I think from what I see in that map that it will be something like 50,000 acres more, and adding the higher lands, up to 175,000 acres from here to the cañons below.

The CHAIRMAN. If you could get the water?

Mr. EUBANK. Yes; raising the water 60 feet high. The valley falls 2½ feet to the mile. After that it falls 2 feet and over; after that a little faster, down to Camp Rice. I do not know what it is. I take it from the railroad, which falls 2 feet to the mile, or 1.9 feet.

The CHAIRMAN. How is it on the other side of the river?

Mr. EUBANK. I have been all along there, and it would be just about equal; one side the same as the other. I have never made a calculation, but that is my observation.

The CHAIRMAN. Are you familiar with western Texas?

Mr. EUBANK. Yes; I spent a year and a half coming out into this country on the Texas Pacific Railroad as an engineer. I know the country there pretty well; walked all over it.

The CHAIRMAN. What do you say as to the feasibility of irrigation in western Texas.

Mr. EUBANK. I think it is feasible up to the point 30 or 40 miles west of the Pecos River, where you strike the mountains. From there east it is feasible to get water from the ground so far as I have observed.

The CHAIRMAN. To what extent can it be practiced from there east?

Mr. EUBANK. Only from wells. There is no water there, except the well water, and we found water from 20 to 30 feet for railroad purposes, stations, and engines, wherever we dug.

The CHAIRMAN. Could the water be stored on the Pecos below?

Mr. EUBANK. The plains are 2,989 feet, the highest point, where the *railroad crosses, and* the Pecos is 2,300 where the Texas Pacific crosses.

You see the difference is about 600 feet below the plains. You would have to go up the Pecos River and get it out on the plains. I do not believe it would be feasible.

The CHAIRMAN. But the valley?

Mr. EUBANK. It could be all brought under cultivation by the Pecos River.

The CHAIRMAN. How much valley is there?

Mr. EUBANKS. On the eastern side, before it comes to the hills, it is 2½ miles where the railroad crosses; but going west it comes 2 miles out and rises four-tenths of a foot to the 100 feet.

The CHAIRMAN. You do not know to what extent the Pecos could be brought on that ground?

Mr. EUBANKS. I went up on the Pecos River 6 or 8 miles from the railroad, and I have been farther than that from the railroad.

The CHAIRMAN. Is that good land?

Mr. EUBANKS. Yes; it appears to be good land. Down near the river it is alkali; but when you get away from the river it is splendid land.

Senator REAGAN. Have you made any examination that would enable you to say whether a dam built here, as has been spoken of, 60 or 75 feet high, would throw water out on the mesa on the east side of the river?

Mr. EUBANKS. The mesa is 170 feet above this town, and the highest point of the mesa is 374 feet above this town. In order to bring a ditch around this mountain San Marcial onto that land, by obtaining a grade of 1 foot to the mile to bring it out on this vast plain, you would have 30 or 40 feet cutting for a half mile.

Senator REAGAN. How much land would it open to irrigation?

Mr. EUBANKS. About 1,000,000 acres any way.

Senator REAGAN. What is the distance that you speak of where it would be necessary to bring that ditch out?

Mr. EUBANKS. One hundred and fifty or 160 miles; 120 miles.

Senator REAGAN. What would be the length of the ditch before you reached the San Marcial?

Mr. EUBANKS. You might add 20 per cent to the railroad for the windings of the ditch. The ditch would not be as straight as the railroad.

The committee took a recess, and on re-assembling heard the

STATEMENT OF LUDWIG HELDT, SURVEYOR OF EL PASO COUNTY.

The CHAIRMAN. Are you familiar with the topography and sources of water-supply for irrigation in western Texas?

Mr. HELDT. Yes; I am well acquainted with some of the latter.

The CHAIRMAN. State what you know of them?

Mr. HELDT. I was division engineer of the Southern Pacific Railroad for some years, and I am well acquainted with the Devil's River and part of the Pecos and nearly all the waters between here and San Antonio.

The CHAIRMAN. Go on and explain that.

Mr. HELDT. In Devil's River I have taken an extra interest, because a friend of mine asked me if it was possible to irrigate by damming the river, and I went out there and made a special examination of it. At another time I was at the head of the river.

Devil's River is an overflow from a small lake near Beaver Lake in Crockett County, Tex. *It is a free flowing* stream of clear water, and

is everlasting. There is a rock bottom all the way, and it is very easily dammed up, and can be spread over 50,000 acres of land near Del Rio.

The CHAIRMAN. Do you think that there is a sufficient water-supply, if it were stored, to irrigate 50,000 acres of land?

Mr. HELDT. Yes, I do. They are irrigating 12,000 acres of land at Del Rio and at San Felipe Spring, and that spring must come from the Devil's River somewhere, because every time that river is up the spring rises, and when Devil's River is low it falls. But this San Felipe Spring is also everlasting. One curious thing about it is that they tried to dam it up a couple feet higher a few years ago; they found that it would not flow more, and that is my reason for thinking that there is water from the Devil's River, and by damming up the Devil's River I think this San Felipe spring will rise so much higher that they could irrigate nearly twice the land. That is my impression, and I think that I am right about it.

The CHAIRMAN. Then what is the next stream?

Mr. HELDT. That is the only stream that I have made any special study about.

The CHAIRMAN. Have you traveled over the others?

Mr. HELDT. Yes.

The CHAIRMAN. What is the next stream?

Mr. HELDT. There are no streams any farther down until you get to San Antonio River.

The CHAIRMAN. How far is Devil's River from here?

Mr. HELDT. Four hundred and fifty miles.

The CHAIRMAN. Is there any stream between that and here?

Mr. HELDT. There is the Pecos River. There is no irrigable land between Fort Quitman, 80 miles below here, and Del Rio, 90 miles below that point.

The CHAIRMAN. What is the next stream?

Mr. HELDT. The Pecos River.

The CHAIRMAN. No streams between?

Mr. HELDT. There is a small stream at Langtry, but it is in a cañon about 120 feet deep.

The CHAIRMAN. Are there no cañons or arroyos that have storage facilities?

Mr. HELDT. No; not between the Pecos and Devil's River.

The CHAIRMAN. What is the distance between Devil's River and Pecos River.

Mr. HELDT. Fifty miles; and that is the roughest country in the world.

The CHAIRMAN. Have you been up the Pecos?

Mr. HELDT. No, not for any distance. Well, I have been on horseback when I was trading cattle.

The CHAIRMAN. How much of a stream is the Pecos in flood time?

Mr. HELDT. In flood times I have known it to be 30 feet deep—up to the bottom of the bridge of the Southern Pacific Railroad.

The CHAIRMAN. How wide?

Mr. HELDT. One hundred and fifty feet wide.

The CHAIRMAN. Can you give an estimate of the quantity of water that runs in it?

Mr. HELDT. No.

The CHAIRMAN. Have you ever gauged it?

Mr. HELDT. No. Well, I think it would be possible to dam up those draws and irrigate some of that country there.

The CHAIRMAN. Where?

Mr. HELDT. About Murphyville and Marfee. That is a level country.

The CHAIRMAN. What surveys did you make?

Mr. HELDT. I made a survey of the river from here to a point about 10 miles below Fort Hancock.

The CHAIRMAN. And made a map? was that your map that was shown to the committee?

Mr. HELDT. Yes, sir; also a survey of an irrigation ditch to be used in connection with this proposed dam from Fabens to Fort Hancock.

The CHAIRMAN. What amount of land is there on the American side that can be reached from the ditches of this dam?

Mr. HELDT. I think there will be 125,000 to 150,000 acres between Fabens and Fort Hancock. By actual measurement I have found it 136,000 acres.

The CHAIRMAN. How much on the Mexican side?

Mr. HELDT. An equal amount.

The CHAIRMAN. In running your ditches, how far from the top of the dam would you take the water?

Mr. HELDT. Forty-five feet from the bottom of the dam. I used the Southern Pacific grade all the way down.

The CHAIRMAN. That will leave about 15 feet of water.

Mr. HELDT. Yes.

The CHAIRMAN. Do you think that will be sufficient to irrigate 135,000 acres of land?

Mr. HELDT. I really have not made that a study.

The CHAIRMAN. How many acres would 15 feet of water in that dam cover a foot deep?

Mr. HELDT. I would have to have some time to figure that out.

The CHAIRMAN. How much land could you irrigate if you came up six feet from the bottom?

Mr. HELDT. Fifty thousand acres.

The CHAIRMAN. If you came up 20 feet, how much?

Mr. HELDT. The increase would be rather gradual.

The CHAIRMAN. Is it proposed to make different places to draw the water out at different heights of the dam?

Mr. HELDT. I think not.

The CHAIRMAN. I think they ought to do that.

Mr. HELDT. I think the dam will be solid for 40 feet.

The CHAIRMAN. It ought to be solid at the bottom, too. In surveying the ditch from the proposed dam down to the cañon on the Colorado, you found that the river had been changing its bed very much?

Mr HELDT. Yes, very much.

The CHAIRMAN. And that the boundary is very uncertain?

Mr. HELDT. Yes, very uncertain.

The CHAIRMAN. In what respect has it been changed?

Mr. HELDT. In some places changed for 3 miles and over.

The CHAIRMAN. And it is continually changing?

Mr. HELDT. Continually changing, yes, sir.

The CHAIRMAN. Do these changes take place in flood times or are they constantly occurring?

Mr. HELDT. They always occur in flood times.

The CHAIRMAN. No change when water is low?

Mr. HELDT. No.

The CHAIRMAN. Then, if the flood waters were retained you do not think there would be any changes?

Mr. HELDT. *I do not think there would* be any changes.

The accompanying papers, reports, and statements were received and ordered filed by the committee.

Adjourned.

STATEMENT OF ANSON MILLS, MAJOR TENTH CAVALRY, U. S. ARMY, CONSULTING ENGINEER OF THE U. S. GEOLOGICAL SURVEY AT EL PASO.

While on leave of absence here last fall, I submitted to the city council of El Paso the project for a dam and reservoir in the Rio Grande, above this place; later on, while in Washington, I presented the same to the Director of the Geological Survey, Major Powell, who gave me such kindly encouragement that on the 10th of December, at the request of the then Secretary of State, Mr. Bayard, I wrote and he had printed a detailed explanation of my project, which is inclosed herewith, marked A.

In April, 1889, at the instance of Major Powell, I received the following order from the War Department:

Special Orders, No. 85.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, April 12, 1889.

[Extract.]

* * * * * * *

6. With the approval of the Secretary of War, Maj. Anson Mills, Tenth Cavalry, will report for temporary duty to the commanding officer, Fort Bliss, Tex. In addition to his military duties at that post, he is authorized to extend his services in every proper way, when they may be requested, to the officers of the Interior Department in charge of the Geological Survey on that part of the Rio Grande 60 miles north and 60 miles south of the El Paso, Texas, this survey having for its object the redemption of areas of irrigable lands in the Rio Grande Valley. The travel enjoined is necessary for the public service.

* * * * * * *

By command of Major-General Schofield.

R. C. DRUM,
Adjutant-General.

Official.

J. C. KELTON,
Assistant Adjutant-General.

Major MILLS,
Worcester, Mass.

On reporting to the Director of the Geological Survey I received verbal instructions from him to make all reasonable investigations that would tend to develop the feasibility of my project, and the following written instructions:

DEPARTMENT OF THE INTERIOR, U. S. GEOLOGICAL SURVEY,
Washington, D. C., April 20, 1889.

SIR: I have the honor to acknowledge the receipt of your letter of 15th instant transmitting a copy of Special Orders, No. 85, current series, from the commanding general of the Army, authorizing you to extend your services, in every proper way, when they may be requested by the officers of the Interior Department in charge of the Geological Survey and its action with reference to improvements of the Rio Grande River, near El Paso.

In reply thereto I hereby request that you will act as the advisory agent of this Bureau in respect to matters connected with improvements of the Rio Grande River near El Paso, and relation to the use of its waters for purposes of irrigation. You are requested to keep this Bureau informed of all projects looking to such purposes and to communicate to it your opinions and advice thereon. In view of the fact that any works affecting the flow of the Rio Grande River must be matters of equal solicitude to the people of the United States and of Mexico, and to their respective governments, you are especially requested to acquaint yourself, so far as may be, with the *views of the Mexican* officials and people in relation to such matters, maintaining in *your intercourse with* them a most friendly attitude and representing to them a sin-

cere and earnest desire of this office to treat all matters relating to the use of the waters of the Rio Grande for purposes of irrigation with a due regard for their rights.

It is the purpose of this Bureau to establish at El Paso a station for gauging the annual flow of the river, for measuring the evaporation, and for other purposes, and I should be pleased if you will exercise a supervision over this work of the employés, who will be instructed to report to you, and I further request that you will assist them in securing facilities for their work.

Very respectfully, sir,

J. W. POWELL, *Director.*

Maj. ANSON MILLS,
Tenth Cavalry, U. S. Army, Worcester, Mass.

EXHIBIT A.

EBBITT HOUSE, *Washington, December* 10, 1888.

SIR: Agreeable to promise at our interview this morning, I have the honor to submit the following general outline of my projected scheme for an international dam and water storage in the Rio Grande, near El Paso, Tex., for the control of the annual floods and the preservation of the national boundary to the Gulf, and for other purposes.

The Rio Grande, 1,800 miles long, rises from an unusual number of tributaries in the very high altitudes of southern Colorado and northern New Mexico, where the rain and snow fall is extraordinary, and the ice formed therefrom in the long winter enormous. As it flows southward the precipitation gradually decreases for 600 miles, when the Mexican boundary is reached, at El Paso, Tex., where there is neither snow nor ice, and but 8 inches annual rain-fall; from thence, 1,200 miles south, to the Gulf of Mexico, the rain-fall is only sufficient to compensate for the loss by evaporation (which latter is very great); and, for these reasons, the river has but few tributaries, and no increase of flow below El Paso.

The annual floods, caused by the melting of the snow and ice in the mountains, take place in May and last for about seventy-five days, during which period the average flow may be estimated at 200 yards in width by 2 yards in depth, with a velocity of 5 miles per hour, although in recurring periods of about seven years it is much greater. During the remaining two hundred and ninety days of the year the average flow is, perhaps, not over 30 yards wide by 1 yard deep, with the same velocity; and in the same recurring periods in the intervals between the high tides the river goes dry for months, as it is at this time, or at least has no current, with not enough water in the pools to float the fish.

There is a present popular opinion that this want of water comes from its diversion by the numerous irrigating canals lately taken out in Colorado and New Mexico, and while it is problematical what effect this may have, if any, I am of the opinion that most of this water returns to the stream again, either through the atmosphere, by evaporation and precipitation, or by the earth, through overflow and drainage, as, from personal observation, I know that these seasons of flood and drought were of about the same character thirty years ago.

After leaving the mountains the river passes through low valleys of bottom lands from 1 to 12 miles wide, and from 4 to 8 feet above low water level, of a light, sandy alluvium formed during annual overflows by sedimentary deposits from silt, which the water always carries in a greater or less degree.

In meandering along the Texan bank of the river, as a land surveyor, from the New Mexican line to a point below Fort Quitman, in 1858, 1859, 1860, I observed that the deposit was from one-half to 3 inches annually; that during the floods the bed of the river was constantly changing by erosion and deposit; and that in regular cycles it shifted from one of its firm rocky or clay banks to the other as the deposits had raised the side of the valley through which it then flowed above the level of the opposite side. Generally this change took place slowly by erosion and deposit of matter entirely in suspension; but frequently hundreds of acres would be passed in a single day by a cut-off in a bend of one channel and sometimes the bed would suddenly change from one firm bank to the other, a distance of perhaps 20 miles in length by 6 in width, for instance.

When surveying "El Canutilo," a valley a short distance above El Paso, the river was moving westward, and about the middle of the valley, which was some 6 miles wide, old Mexicans who had lived in the vicinity informed me that in 1821 the river ran close along the eastern bluff, where its bed was plainly to be seen, as was also a less plainly outlined bed along the bluffs on the opposite side where the river flows at this date, and gives evidence of returning abruptly to the eastern bluffs again at

the next greatest high tide, to its old channel, along the bed of the track of the Sante Fé Railroad.

In another case, more recent and extensive, in the great valley below El Paso, some 12 miles in width and 20 miles long, the river, as was plainly evident at the time I was surveying the land, had made a sudden change from the bluffs on the eastern or Texan side to the western or Mexican side of the valley.

Mexicans, who had been residents continuously in that vicinity, informed me that this change took place in 1842.

Again, in 1884, in this vicinity, the river swept suddenly from the Mexican side, crossed the Southern Pacific Railroad, and destroyed both track and bed for a distance of 15 miles, stopping traffic for a period of three months and causing the removal of the road to hills above the valley.

Though these are the most extensive changes that came within my personal observation, similar ones are being made annually, from El Paso to the Gulf, which not only prevents the settlement and development of such of the lands as are sufficiently above the overflow (were the banks and boundaries secure), but, by reason of the river being the national boundary between the United States and Mexico for over 1,200 miles, cause fatal embarrassments to the citizens and officials of both republics, in fixing boundaries and titles to lands, in preventing smuggling, collecting customs, and in the legal punishment of all crimes and misdemeanors committed near the supposed boundary line, it being easy at almost any point in its great length to produce evidence sufficient to raise a reasonable doubt in the minds of the jurors as to which side of the line the arrest was made or the act committed.

At the last session of Congress the House passed a joint resolution (No. 112) requesting the President to appoint a commission, in conjunction with a similar one from the Republic of Mexico, to consider the matter above referred to. While surveying these lands in 1858, and prospecting for a crossing of the Rio Grande for the Memphis, El Paso and Pacific Railroad, which was then projected and, in fact, in course of construction, I examined the pass about 3 miles above the present city of El Paso, and discovered that it had solid rock bed and walls, the latter but about 400 feet apart, and that the valley above which came close down to the spur of the Rocky Mountains, which crossed the river and formed the pass, was from 4 to 8 miles wide, with a fall of about 4 feet to the mile, so that it would be an easy matter to build a dam in this pass and create an immense lake.

The water coming through this pass for ages has deposited at its lower end a great mass of rocks, over which is formed rapids with about 12 feet fall, and the aborigines of prehistoric ages made use of this to carry the water on to the lands below—no one knows how long ago; but it is known that the Mexicans have used it for two hundred years, under most disadvantageous and unsatisfactory circumstances.

I have witnessed, each succeeding year, hundreds of Mexicans piling loose stones on the top of this drift of rocks to raise the level to that carried away by the floods of the preceding year; and it has been estimated by a Federal engineer sent from the City of Mexico, that, had the labor thus expended been reduced to silver, the dam could have been built of the solid metal.

The difficulty has been, and always will be, that there is neither bed-rock nor solid earth in the bottom or banks, each being composed of quicksand.

In other places in the valley, temporary willow dams, 1 or 2 feet high, are made at convenient places, and the water carried several miles below on to the lands that are above the usual overflow; but these dams are carried away annually, and have to be rebuilt, and frequently the river bed moves miles away from the mouth of the ditch or acequia, rendering it useless, but even if these difficulties in carrying the water from the bed of the river to the lands are overcome in the usual manner, it is evident that by reason of a great overflow—say every seventh year—and a dry river in a like period, no system of irrigation for the Rio Grande can prove satisfactory that does not embrace a grand storage system sufficient both to restrain, to a great extent at least, the tidal flow and maintain a costant annual flow, especially since the great emigration and settlement in its valley is constantly doubling the demand for water.

Being on leave of absence in the city of El Paso recently, where I was a citizen before the war, having surveyed the first plat of the town, and being well known to most of its citizens, I was invited by the city council to submit to it a plan for water supply and irrigation that would overcome the difficulties above referred to.

It at once occurred to me that, as the Rio Grande was the joint property of the two nations, and especially as the Mexicans had used its waters since time when "the memory of man runneth not to the contrary," that any plan to be acceptable and satisfactory must be international in character, and the works, both before and after completion, under the joint Federal control of the two nations—the more so as riparian rights in this country, so far as regards irrigation, are not well defined by law and could be best brought about in this instance by treaty stipulations between the *two countries.*

The matter of restraining the tidal flow by storing the water, and thus protect the constantly-changing national boundary, occurred to me, if it could be introduced into the project, as likely to secure encouragement and substantial aid by liberal appropriations in money from both Governments.

And further, that at El Paso (now a city of over 11,000 population, with every prospect of being a large manufacturing city at no distant day, there being no place within 500 miles likely to compete with it), the subject of water-power ought also to enter into the problem, which of necessity is of such vast proportions as to require all incidental aid possible to attach to it to insure its success.

It will be apparent, from what has been written, that the Rio Grande is one of the first magnitude, not only in length and breadth, but for short, annual periods in devastating flow of waters, and that its general characteristics, as compared with other rivers with reference to irrigation, are so abnormal as to require different and more heroic treatment.

I therefore projected a scheme which may be briefly outlined as follows: To build a strong dam of stones and cement—say 60 feet high—in the pass before referred to, and by submerging about 60,000 acres of land now subject to overflow, and of little comparative value, create a vast lake 15 miles long by 7 miles wide, with a probable storage capacity of 4,000,000,000 cubic yards of water; place gates on each side of the river in the dam at the 50-foot level for waste wiers and irrigating canals to supply each side of the river and keep up a flow in its bed, which would bring the water in the canals 70 feet above the streets in the cities of El Paso and Juarez, respectively.

The gates at the 50-foot level would give an available reserve of water of 10 feet over the entire surface of the lake, over 2,000,000,000 cubic yards, which would be exhausted during the long season of little flow for the purposes of irrigation and other needs, as well as maintaining a constant stream in the river beds so arranged as to exhaust the reserve about the period of annual flood, which would be checked and held in reserve for the next season of little flow, and in this manner produce a comparatively constant and unvarying flow of the water for each entire year below the dam, redeeming many times the number of acres submerged above in the lake from overflow below, and fixing permanently the national boundary, the banks of the river, as well as the boundaries and titles to private lands, and making it an easy matter to collect duties and prevent smuggling, detect crimes and misdemeanors generally, arrest and punish criminals, as it is along other national boundaries.

The assumed flow given for the seventy-five days of high water will give about 7,500,000 cubic yards, and that for the remaining two hundred and ninety days 1,500,000,000 cubic yards, making an aggregate annual flow of 9,000,000,000 cubic yards. If we allow 3,000,000,000 of this for loss by evaporation and other wastes, which former, in this dry atmosphere, is very great, perhaps 20 inches, we have 6,000,000,000 cubic yards, and dividing this into three equal parts, one for each side of the river for irrigation and other needs, and the third for overflow through water motors to furnish power to the future manufacturing cities on each side and to maintain a constant flow in the river below to the Gulf, as would no doubt be demanded by the people there as their right ere they would permit the scheme to be carried out.

The 2,000,000,000 cubic yards falling a distance 50 feet over the dam, estimating the weight of a cubic yard of water at 1,500 pounds and one horse-power, the energy required to lift 33,000 pounds 1 foot in a minute would expend energy equal to over 30,000 horse-power for eight hours every day in the year, and produce a constant stream in the bed of the river 26 yards wide by 1 foot deep, running with a velocity of 5 miles per hour, to say nothing of the probability that the greater part of the other two-thirds would find its way again to the river-bed through the earth and air, the whole flowing in a steady, continuous stream to the mouth of the river, to be used as required at any season of the year, instead of, as is now the case, six-eighths of the entire mass of the annual flow going rapidly to the Gulf in the short period of seventy-five days untaxed.

Estimating the amount of water required for annual irrigation at 20 inches, the water reserved for that purpose would be sufficient for 1,000,000 acres on each side of the river, all that could be reclaimed from the desert for 100 miles below.

To carry out this project, I recommended to the people on each side of the Rio Grande that they petition to the executive authority of their respective nations for the creation of a joint commission, to draw up the necessary treaty stipulations to protect the work and the rights of all interested in them, the fundamental feature of which should certainly be that each nation should have the right to divert no more than one-third of the flow at any period, and that one-third the flow should be maintained in the bed of the river, and that this international commission have charge and control of the work after completion as well as during construction.

That the legislative authorities of the two nations be asked to appropriate, after complete investigations and estimates have been made, money sufficient to complete

the work, probably $100,000 for the dam proper, $100,000 for the condemnation of the 50,000 acres of land to be submerged, and $100,000 for the removal of some 15 miles of the road-bed of the Atchison, Topeka and Santa Fé Railroad to bluffs above the old bed of the river, where the track now lies, subject to annual damage, and sooner or later, total destruction, unless removed.

It will also be apparent that the waters of this great lake will be clear and fresh, the silt held in suspension in the current of the river being precipitated as soon as it enters the still water of the lake, doing away with the great trouble and expense now necessary in keeping the canals and ditches cleansed of sedimentary deposits, and a further great benefit derived from using water reduced in temperature by exposure for months in a warm climate far below that used in the early spring, which comes in three days from snow and ice and is immediately applied to the young and tender sprouting plants, chilling and checking their growth.

I know of no point on the Rio Grande—between Albuquerque and the Gulf of Mexico—where nature has provided both the natural basin and rim for a lake of such great dimensions—for indeed it can be made 100 feet deep, if desired, and it may be questioned whether a depth of 60 feet with 10 feet reserve to draw from will afford sufficient storage to control perfectly the tide at its highest flow.

This project was well received by the people, and has been earnestly discussed in the public press of the locality ever since, with general approbation and a disposition to endeavor to carry it out as quickly as possible; the only question exciting any general distrust being that of the sedimentary deposit in the lake, which, it is held by some will shorten the life of the reservoir by filling the lake at such an early period as to render the scheme of doubtful expediency, and opinions differ very widely upon this subject, which is indeed a problematical one, and can only be determined even approximately by actual measurements of a great majority of the annual flow, for the quantity of sediment changes with flow and season.

That the bed of the river will eventually be filled, of course is only a matter of time; but whether in fifteen or one hundred and fifty years can only be ascertained by prolonged actual measurements; but, even if filled in the near future, it seems to me that the difficulty may be overcome by raising the dam, unless, indeed, that should be required too often.

The matter has already been referred to Major Powell, Chief of the Geological Survey, who has sent Capt. Clarence Dutten, of his department, to El Paso to investigate and report upon the feasibility of the scheme; but as the initial steps, should it be pronounced feasible, must come from your Department in the nature of international treaty stipulations, I have thought it proper to thus early acquaint you with the grand project.

I beg to refer you to the Hon. Mr. Lanham, member of Congress from Texas, who is acquainted with me personally and my projected scheme.

ANSON MILLS,
Major, Tenth Cavalry, Brevet Lieutenant-Colonel, U. S. Army

The SECRETARY OF STATE,
Washington, D. C.

EXTRACTS FROM MAJOR MILLS'S ANSWER TO CIRCULAR OF INQUIRY.

The country is certainly to be congratulated that Congress has so willingly and generously taken the initiative in making appropriations for experimental examinations, indicating a purpose of putting the matter on a footing with other internal improvements. While I lay no claim to any special attainments in the particular sciences applicable to the development of the great and grand schemes that are certain to be brought forward and accomplished in the near future, I feel that a youth spent in tilling the soil, and a manhood mostly spent on the arid plains of the Great Southwest, whereby I have obtained that general knowledge of its characteristic features that observation alone gives, but, more than all, a familiar acquaintance for the past thirty years with the abnormal characteristics of one, of the greatest rivers in the great North American continent, and destined, in my judgment, to cut a greater figure in the matter of providing water for irrigation than any other in the United States—the Rio Grande—has qualified me to say something of interest on the subject.

I beg to submit herewith as a part of my report (see Exhibit A), a copy of a letter addressed by me to the honorable Secretary of the State on the 10th of December, submitting a project for controlling the annual floods in the Rio Grande and the preservation of the national boundary between the United States and Mexico, incidental to which there would be derived great facilities to both nations for irrigation and water-power. What is said of the Rio Grande is true of all the larger rivers in the arid regions; *they are all essentially* torrential in character, at times carrying great floods and

again dry, the latter condition generally happening in the season of irrigation, hence the generally unsuccessful efforts, almost universally practiced until recently, of attempts to take water immediately from the river beds without dams or reservoirs to the lands to be irrigated, allowing vast volumes to pass when not needed and being at the season most needed, in some years powerless to carry anything, and manifesting clearly the absolute necessity of abandoning present methods, and resorting to the more expensive, yet more certain and economical methods, of large dams and reservoirs. In soil, heat, and light, all so essential to vegetable growth, these arid regions are generally favored by nature above other parts of the country, and water is generally available in abundance if properly preserved until the time of need, and I predict that if the time shall ever come when even the greater portion of it is held in lakes and reservoirs, instead of being permitted, as now, to go quickly to the sea, that the high winds and extreme aridity of the atmosphere, now so prevalent and detrimental to vegetable growth, will be decreased by the exposure of large surfaces of water, creating greater humidity and more precipitation in rain and dew and a temperament of the extreme heat of the midday, thus modifying the parching dry winds.

My letter above referred to was perhaps the prime cause of my being stationed at this post under Special Order No. 85, current series, from the War Department to assist the officers of the Geological Survey in the preliminary international accommodations and adjustments between two peoples here and the preparation of the necessary surveys, plans, estimates, etc., to present the project in an intelligent form to Congress at its next session with a view to the procurement of an appropriation at as early a date as possible for the accomplishment of the work, in conjunction with similar agencies from the Mexican Government, the scheme in its entire scope being essentially an international one, the waters of the river being the joint property of the two nations. I have purposely delayed this report until this late day that I might be able to show some progress in the project which I have so much at heart and which I trust may not prove entirely uninteresting to those in authority over me.

I arrived here May 4, and at once presented my letter of instructions from Major Powell to Mr. Garfias, the Federal engineer; Colonel Candano, the Jefe Politico of the Canton del Bravo, and other local officials of the other side to whom I explained in detail the projected enterprise, which they one and all received in the most kind and encouraging manner, giving me permission to establish one end of my cable for the gauging station on Mexican soil, and promising to assist me generally in any reasonable manner. I then invited Mr. Garfias, the Mexican engineer, to co-operate with me to any extent he might see proper by accompanying me in my investigations, surveys, and measurements, that his Government might have a knowledge of all preliminary work in the matter from the beginning. He replied that he would take the responsibility of doing so at once, pending action on official application which he would at once make to his superior, the minister of public works in the City of Mexico, and later on he furnished me with a copy of the minister's authorization, and he has continued to inform himself with the nature of all our work.

On May 6, Messrs. Williams and Dyar reported to me, and we proceeded at once to procure the material for the establishment of the station for the measurement of the flow and evaporation of the water and the silt carried in suspension, selecting a point in the limits of this post and about 300 yards above the old dam in the river for the suspension of the steel cable, and on the 20th we had everything complete, and have continued our measurements to this date with the following general results:

I found the river abnormally low on my arrival May 4, carrying probably but 5,000 feet, and it has continued falling quite regularly, old residents saying that it has carried less water during the same period than they have known for many years. Every indication points to an entirely dry river within a few weeks, to last perhaps for many months, as sometimes happens, though heavy rains on the upper river may prevent. While this will be exceedingly unfortunate for the country, it will assist our investigations very materially in search of the bed rock and the prospects of the project generally.

Our first measurement of flow was taken May 20, showing 4,300 feet, and the last, taken to-day, shows but 100 feet.

The measurements for evaporation began May 10 and have run very regularly, averaging about .35 of an inch per day or 10 inches per month for May and June, but now seem to be decreasing to about .25 daily.

Mr. Dyar has taken almost daily measurements of the silt in suspension since June 10, with results varying from one quarter to one half of 1 per cent. of the water carried, save in one case of local rains, which lasted some twelve hours, wherein the per cent. rose to 1½. The general average of the per cent. of the water carried, according to the assumption that a cubic foot of dry sediment weighs 85 pounds, is .345 of 1 per cent. Assuming this to be correct, and that it will take one year's time for the river to fill the lake with water, *it will* take about three hundred years for the lake to fill *with sediment.*

On the 27th of May, at the solicitation of the United States Senate Committee on Irrigation, the mayor of El Paso appointed Messrs. Bronson, Davis, Magoffin, McCutcheon, and Mills, a committee to collect data, etc., relating to the subject of irrigation, for the consideration of said Senate committee on its expected arrival here in September next; and a few days thereafter, at the solicitation of the mayor of El Paso, the mayor of Juarez appointed Messrs. Sanchez, Padilla, Provencio, Count Duprez, and Superintendent of Public Works Garfias, a committee to act in conjunction with the one on this side, and it is understood that this committee has requested of its Government that an engineer be sent to run a line of levels for a canal from the proposed dam, and to ascertain the quantity of land it would cover for 50 miles below, and that a committee similar to that of our Senate be organized to meet here in September to investigate and discuss with the American committee the international features of the project, to the end that a common and intelligent understanding may be reached at an early day between the two countries in the matter.

Meanwhile, Colonel Nettleton, the supervising engineer of the Geological Survey, visited this station and after a thorough examination of the project, the lands, the river, and the railroads, and an interview with the two committees, jointly decided to make the necessary surveys, plans, and estimates, and employed Mr. W. M. Follett, an engineer, with four assistants, who are now in a camp, the equipage of which was kindly furnished by the commanding officer of this post, doing the field work, and he informs me that he will be able to complete the whole, including the office work, by the time of the arrival of the Senate committee in September.

Colonel Nettleton having informed me that he had been instructed not to make any expenditures below El Paso this year, and seeing the necessity of some data to present to the committee showing the ever-changing bed of the river and the national boundary in the valley below for the past forty years, and also the extent of land that will be covered by a canal from the proposed lake or reservoir, I laid the matter before the El Paso committee, and it at once made application to the county commissioners, through the county judge, Mr. Townsend, resulting in an order from the commissioners to the county surveyor to report to me to prepare the necessary data at the expense of the county, in connection with Mr. Follett's surveys. I will try and arrange that the county surveyor and the Mexican surveyor, in preparing plats of the beds of the river at the different periods, when any considerable surveys of land were made on either side to work in conjunction, that the greatest detail and accuracy possible may be obtained.

I feel that our project is progressing as promisingly as could be expected, and that we shall be able to make such a clear showing to the legislative authorities of the two nations that it will fix and control their boundaries; that there will be little difficulty in arranging the necessary international treaty stipulations, and appropriations in money to complete the work at an early day, laying aside the great "object lesson" it would place before the people of both countries as to the possibilities in the line of irrigation.

I beg to suggest the examination later on of another international project of a similar nature, of a dam in the Rio Colorado at Yuma, a short distance above the Southern Pacific Railroad Bridge, say 30 feet high, that would create a large lake, mostly I think on unappropriated lands, control the floods and boundary below, and afford ample water for the irrigation of vast quantities of land both in Mexico and the United States, and the formation of a lake, say 50 feet deep, in that miserable "Yuma Desert," the center of which would be somewhere near Salton Station, tempering the climate so that the country would be habitable, and providing water for the irrigation of the thousands of acres not covered by the lake, but below the level of the sea. The Mexicans would be the greatest beneficiaries should this project be found practicable and carried out, but it would afford another grand "object lesson" in the possibilities of water storage.

Extracts from Major Mills' Report to E. S. Nettleton, C. E., Supervising Engineer, U. S. Irrigation Survey.

Mexican official action.—After receiving the necessary authority from the minister of public works in the City of Mexico, Mr. Garfias, their engineer, has kept himself advised concerning all our investigations to this date, and I propose furnishing him with a copy of all maps and reports relating thereto with a view to inducing the Mexican Congress (now in session) before their adjournment in January to pass a joint resolution authorizing their President to join the United States in the construction of the dam proper and appropriating $150,000 for that purpose should our Government make a like appropriation; this for the purpose of gaining a year's time in the *commencement of* the work.

Measurement of evaporation.—May 6 Messrs. Williams and Dyar reported to me. Measurements for evaporation began May 10 and were continued until the present date with the following results:

May (twenty-one days, 11th to 31st)	7.31
June	11.23
July	9.05
August	10.85
September	8.20
Total	46.64

A total of 46.64 inches for one hundred and forty-three days, or a mean of .32 of an inch per day. As these one hundred and forty-three days embraced the season of greatest aridity, it is probable that the annual evaporation will be about 6 feet.

Measurement of flow.—May 20 our gauging station was established, the first measurement taken that day showing 4,300 cubic feet per second; the last, taken July 30, showing 30 cubic feet. On August 5 the river ceased to flow, and has not carried any water to this date, though some small pools of water are still to be found in the pass, sufficient to float the evaporation pans. During the measurements of flow the fall of the river was very continuous and gradual, and other conditions favorable to the projection of curve for the measurement of highest flood as shown by drift marks, but, unfortunately, about the middle of our observations the crest of the Mexican dam, only 300 yards below the station, was raised about 12 inches, distorting the projection of the curve so that no reliance could be placed upon it. The river probably carries about 9,000 cubic feet at highest flood, and perhaps an annual average of about 1,200 cubic feet per second.

Measurement of silt.—Between June 10 and July 28, one hundred and eighteen samples of water were taken from different parts of the river's current, and the sediment of each carefully measured, with the following results: The average of the per cent. of the volume of water carried, according to the assumption that a cubic foot of dry sediment weighs 85 pounds, is .345 of 1 per cent. The results varied from one-quarter to one-half of 1 per cent. of the water carried save in one case of local rain, the flood of which lasted some twelve hours, wherein the per cent. rose to 1½.

Assuming this to be correct and that it will take one year's time for the river to fill the lake with water, it will take about three hundred years for the lake to fill with sediment; this, however, is making no allowance for evaporation, which is very great (possibly on the surface of the lake one-fourth the annual flow), or for the moving quicksand in the river's bottom, or the detritus to be thrown into the lake by storms from the gulches and ravines from its mountainous sides.

It is, however, safe to assume that at least one hundred and fifty years must elapse before its basin can be filled with solid matter. If these premises be correct it should be remembered that each year one, one hundred and fiftieth part of the lake's basin will be filled with solid matter, thus decreasing year by year its storage capacity in that proportion; but the date when any or all of these causes may destroy its efficiency is so remote as to be unworthy of consideration. This silt problem seemed to be the most formidable one confronting the enterprise. After it had been favorably determined you visited the locality, inspected the proposed sites for dam, the basin for the lake, and the location of the two railroads, from an engineer's stand-point, and decided to have preliminary surveys, plans, and estimates for the entire work made as quickly as possible in order that the project might be presented to Congress at its coming session. * * *

Soundings for bed-rock.—The soundings for bed-rock were made under my supervision in the following manner: The rods were of octagonal cast-steel, printed as a square pyramid, one for shallow soundings of one-half inch steel 18 feet long, another three-fourth inch and 32 feet long for medium soundings, and still another double rod, jointed in two sections, of 1 inch, 26 feet long, each for the deeper soundings. A tripod 20 feet high with a ring in its apex was necessary to keep these flexible rods in a perpendicular position while being worked by four men with two iron clamp-bars, arranged to adjust to any part of the rod as it passed down. The entire 3 miles of the pass were prospected for the bed-rock at all points where the walls of the cañon rendered it practicable to build a dam; but only two available sites were found, the 52-foot rod failing to touch bottom at other points. * * * It is not absolutely certain that the true bed-rock exists as described in the soundings, or if it does exist that it is free from faults or rifts, or of such a quality as to support a dam of the kind designed; but every evidence possible with such soundings was obtained, being the more positive at the lower site by reason of the rock being so much nearer the surface, and the friction on the rods consequently much less. The rod rang out clearly when in contact with the rock at the lower site, while at the upper it was dull and indefinite. Before any permanent work is commenced, the fact of the ex-

istence of suitable bed-rock should be determined by boring out cores from it with a diamond drill.

Relative merits of the two dam-sites.—The upper site has but two advantanges over the lower one; the first being that it is of sufficient distance from the Santa Fé depot to allow that line to be rebuilt on its ruling grade and rise above the dam, which it is impossible to do from the lower site, it being 2 miles from the depot; the second, that the walls of the cañon will allow the dam to be built higher, should it ever be desired.

The lower site has many advantages over the upper one; first, the cost will probably be one-half that of the upper, the bed-rock being but 22 feet from the water-level at its deepest part and for the greater distance across the channel from 2 to 9 feet only, while the upper site is from 30 to 50 feet for the entire cross-section. The old Mexican dam, which has a fall of about 12 feet, is about 1,000 yards below this site, and by breaking this and opening a channel through the sand to this site, I think the water could be lowered 8 or 10 feet, so that the bed-rock for the greater part of the cross-section would be presented above the water; it would be necessary of course to do this in a season of low water and perhaps to flume the channel with lumber. In this manner I think this dam might be completed in one year, and if commenced at the right season the flood-waters of that year reserved. At the upper site it would take one year to build the coffer-dams and get the masonry above water. I have suggested a double curvilinear dam with three heavy buttresses, which I think well adapted to that site. These buttresses could be built in the manner indicated by moving the middle one a little nearer the left bank than shown by the pencil mark entirely out of water. Other advantages are that one end of the dam would be on Mexican soil, and that 1½ miles of expensive and difficult canals on either side would be avoided.

To have the benefit of these advantages, however, it is necessary to get the Santa Fé Railroad above the water in the lake.

It will be observed that the Southern Pacific in its north-bound course leaves the valley just before reaching the lower dam-site and climbs the bluff behind the smelter, crossing two arroyas marked A and B, on Mr. Follett's map No. 1, and on a down grade before reaching the bridge. It has occurred to me that the two roads might be adjusted to use a common double track from Fort Bliss, with a cut about 15 feet deep in the bluff behind the smelter, and by a strong retaining-wall built on the fills in the two arroyas mentioned, so that their tracks would be some 10 or 12 feet below the surface of the lake behind these walls and yet gain an altitude before reaching the third arroya near the present bridge sufficient to carry them above the waters of the lake. The problem then would be to cross the Southern Pacific over the broad river's channel by heavy and well ballasted crib-piers rising to near the surface of low water in the lake so that all the wood-work might be well preserved by submersion, and a superstructure of such a nature as to be restored independently. If this be practicable it will solve the difficult problem of putting one end of the dam in Mexico, and keeping both railroads exclusively in the United States.

The laws of Texas require joint or union depots in cities where railroads cross each other, and sooner or later the railroads in El Paso will be required to comply with them. Should the dam be built the radical changes wrought in the two roads mentioned above will no doubt hasten other adjustments in the city, and, as neither have any permanent depots, will probably result in a union depot, in which case the Southern Pacific would doubtless depart west on the south side of the Santa Fe, which would obviate the present crossing, which gives trouble in any adjustment for the dam.

I beg to recommend that on the first intimation of favorable consideration by Congress of this project, that an engineer be sent here to investigate the practicability of this double track and retaining-wall for the easement of the grade of the Santa Fe to enable it to rise over the water of the lake formed by a dam at the lower site.

Agricultural features.—The land that would be brought under a high-line ditch from this lake, with a fall of 12 inches to the mile for 60 miles below, would be over 100,000 acres, consisting of about 20,000 above the flood-waters of the river and below the waters of the highest ditches now in operation, which would hardly be considered as being redeemed by the project. About 40,000 acres are below the highest flood-waters of the river and about 40,000 more are above the waters of the highest ditches in operation, yet would be below the high-line ditch from the lake, so that 80,000 acres would be redeemed, and could justly be taxed for water rights should the Government see proper to re-imburse itself for the investment. On the Mexican side there would be perhaps 125,000 acres to be brought under their high-line ditch; this estimate is approximate only, no surveys having been made as on our side, though an engineer is about to commence the work.

Water-power.—The water-power made available by the construction of this dam would be of great magnitude. If, as before assumed, the mean annual flow of the river is 1,200 cubic feet per second, and one-half that quantity can be utililized in a

fall of 50 feet over the dam, or from the high-line canals below to the lowlands, for irrigation, we should have 600 cubic feet per second, or 36,000 cubic feet per minute; assuming the weight of a cubic foot of water to be 62 pounds, we have 2,332,000 pounds falling a distance of 50 feet each minute, or 111,600,000 falling 1 foot each minute, which, divided by 33,000, gives us 3,381 constant horse-power, or 10,143 horse-power, less, of course, loss by friction, for eight hours every day in the year. There are few cities on the continent possessing such vast water-power, and, by reason of high price of coal here, it would be of greatest value to the citizens of the sister Republic in this locality. The leasing of this power, should it be thought proper, would produce another revenue for re-imbursement.

Vested water-rights.—The records of Jaurez, formerly Paso del Norte, clearly establish that when first settled by the Spaniards, over two hundred years ago, it was an Indian village subsisting partly upon vegetables raised by irrigation from a ditch and dam in the same location as the one now in existence; that this was a loose bowlder stone dam yearly repaired by piling bowlders on those not carried away and buried in the quicksand below by the floods of the preceding year. This process was continued until within the last six years, when efforts have been made to form a cement cresting on the dam, but it too has been annually destroyed. In 1827 Juan Maria Ponce de Leon made the first settlement on the left bank of the river, on a narrow strip of land then forming under the hills opposite Paso del Norte, and by common consent took a ditch from the waters above the dam which has been maintained for the benefits of the residents of this side of the river to this day without the expenditure of a single dollar in the original construction of the dam or the millions that have been spent in its repair. On the annexation of Texas to the United States, over forty years ago, the Mexicans raised no question of assessment or expense of maintenance, but generously continued to divide with our people the waters from their dam, the product of their own labor, there being sufficient for both except in seasons of extreme drought, about once in seven years. Now has come a great change; the river has been entirely dry for nearly three months,* was dry for about the same period last year; the people this side have suffered, but the Mexicans on the other side have suffered much more for the reason that their sustenance comes almost exclusively from agriculture. Should these seasons of drought be succeeded by two more, but a small portion of the population on the Mexican side could remain here for want of subsistence. There are now about 25,000 in the valley for 50 miles below, and an equal number on the American side.

Both the Americans and the Mexicans claim that this drought in the Rio Grande is caused by the taking of numerous ditches from that river and its tributaries by the citizens of Colorado and New Mexico, and it is apparent that it is true, though I am not as well prepared to substantiate the fact as you are. By reference, however, to the "Fourth Biennial Report of the State Engineer of Colorado for 1887–'88," it will be observed that there are over three hundred ditches taken from the Rio Grande and its tributaries in that State. (See pages 287 to 325.) Most of these ditches have had but a short existence and many others are being rapidly taken out, so that from that State alone the peril to the people here of a water famine in the future seems great indeed.

The Rio Grande has a much longer passage through the Territory of New Mexico, and it is well known that much water is being in like manner taken out from that river and its tributaries in an increased proportion each year, though I am unable to find any official statistics on the subject.

The Mexicans are in great distress, yet protest patiently that they are being deprived of vested rights inherited for many generations, and that according to riparian laws the United States is under a moral obligation to indemnify them for their loss or make some reparation, such as the construction of the projected dam and reservoir. I am not qualified to discuss the legal aspects of this case, but leave it to other hands.

Boundary line.—The "deepest channel" of the Rio Grande, except when "changed abruptly into a new bed by eruption or evulsion," is understood to be the boundary line between the United States and Mexico. The prime object of this project is to fix and control that boundary.

It is certain that it will do this for at least 200 miles below, if a comparatively constant flow of clear water unburdened by silt is allowed to pass through the dam into the channel constantly and the channel straightened and shortened by numerous cut-offs in the great bends so as to give greater fall and a better alignment below 200 miles; the river has two considerable confluents, in the Pecos from Texas and the Concho from Mexico, the floods of which may possibly cause some changes, as they carry considerable silt.

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*Superintendent Ennis of the Southern Pacific Railroad has since informed me that the wells of his road between this place and Hancock are failing.

I believe the reservoir in the lake will in the main control the boundary line from these tributaries to the Gulf of Mexico.

For the past forty years the river has been so continuously shifting its bed from one side of the valley lands to the other with each succeeding flood of water (in many cases unknown whether by evulsion or gradual erosion and deposit) that it is impossible to determine to which nation the land on either bank of the river belongs, for a great portion of the distance through the alluvial valleys, to say nothing of the fact that these lands are almost valueless by being submerged and rendered impracticable of permanent occupancy.

* * * * * * *

In order to illustrate graphically the changes made by the river, Mr. Townsend, the judge of El Paso County, with the approval of the commissioners, directed their surveyor, Mr. Heldt, at the expense of the county, to make the necessary surveys to determine the exact location of the river at this date, and from the sefield-notes and the surveys of other dates on file in his office to compile a map showing the changes that have taken place in the past forty years between the line of New Mexico and Fort Hancock; also to ascertain the quantity of land that would be brought under the ditch by running a line of levels for a high-line canal (to be taken from the proposed lake) from Fabens to Fort Hancock.

I was informed some time ago by Mr. Garfias, the Mexican federal engineer, that his Government had ordered an engineer to Juarez to make a similar survey of the river and lands on the Mexican side, together with a line of levels for a high-line ditch from the dam.

International features.—As the waters of the Rio Grande as well as the boundary line belongs jointly to the two nations, this project can never be carried out without their perfect concord in purpose and action, and in view of the evident prior rights of the Mexicans and the equally evident fact that they are being deprived of them by the citizens of the United States in Colorado and New Mexico, and the further consideration that they have furnished water from their dam untaxed for forty years to the citizens of the United States on this side, I recommend that the United States Congress take the initiative by making an appropriation to cover the entire expense of the work save the one-half the expense of the dam proper, conditioned only that the Mexican Government shall appropriate a sufficient sum to cover the expense of constructing the other half of the dam and accept this action on the part of the United States as full indemnification for their prior rights alleged to have been usurped, and that an international commission, similar to the one proposed in the House resolution before referred to, be organized for the double purpose of supervising the construction of the dam, changing and straightening the channel of the river, and establishing a permanent international boundary to forever coincide therewith, as far below El Paso as the dam may prove effectual in maintaining a constant channel.

Construction.—As under the most favorable circumstances, with the success of an appropriation from both Governments this winter, at least one season must pass, probably two and possibly three, before the waters from the dam can be available and that in all likelihood these seasons will be like the present and past, depriving the Mexican citizens of "El Canton del Bravo" of occupation and means of support, I further recommend that for the purpose of the entire construction of this project in rebuilding the railroads as well as the construction of the dam proper that the "Alien Labor Act" be suspended so far as it applies to that canton of the Republic of Mexico.

In conclusion, I beg to say that I think the construction of this work essential to the continued existence of these frontier settlements; I believe it an obligation justly due from the Government of the United States to the Americans and Mexicans composing them; that in accomplishing it the Government will be availing itself of the grandest opportunity to set before the whole people an "object lesson" of the very first magnitude in the line of that great national development of redemption of arid wastes now dawning upon the country, and giving promise to exceed all others with which it has been blessed, without compromising its future action in similar internal projects, because this, being international and more a question of the rectification of an international boundary, is unique.

MEXICAN ACTION IN RELATION TO PROPOSED WORKS.

[Extract from El Centinela, of Ciudad Juarez (Paso del Norte), November 24, 1889. Translation.]

The following petition has been addressed by the Mexican committee on the Rio Grande international dam and water supply, to their deputies in the Mexican Congress mentioned below. The editor of El Centinela says:

"The committee is deserving of great honor for the zeal it displays in favor of these towns.

"Water is the life of these settlements, drought their speedy ruin. If we do not take advantage of the opportune moment for regulating the vital subject of water, it will be a weary task at no distant day to repair the mistake and avert the threatened evil.

"People continue to emigrate, driven by hunger, and their departure entails poverty on those who remain.

"What are Guadalupe, Zaragoza, S. Ignacio doing with the protest of El Paso? Will these towns not stir? Is the water question of no importance to them?"

THE MEXICAN COMMITTEE ON THE MILLS PROJECT.

The committee in extraordinary session has resolved to intrust to you the object communicated, in a separate paper, in order that by making use of your influence and of the character lent you by your quality of representative and by your constituency, you may be pleased to entreat of those to whom it pertains the prompt dispatch of the subject to which we refer, which will inaugurate a real state of well-being in place of the melancholy situation in which this locality is placed by the absolute lack of water. We tender in advance our gratitude and protest our attentive consideration.

Ciudad Juarez, November 21, 1889.

DÁMASO SANCHEZ,
President.
IGNACIO GARFIAS,
Secretary.

To our Messrs Deputies in the Congress of the Union:

C. MANUEL RINCÓN, C. JOSÉ VALENZUELA, and MANUELO LEON.

THE MEXICAN COMMITTEE ON THE MILLS PROJECT.

This part of the frontier suffers at present from an absolute want of water, as the river has run dry since the end of July past. The consequences of this drought have been the total loss of the crops in the fields, and the diminution, on an enormous scale, of fruit in orchards, many of the more delicate trees in the latter having died of drought. Six mills, whose motor force was the water, have stopped running. Flocks find no watering places, and families lack the precious liquid, even for indispensable domestic uses. The authorities in order to alleviate to some extent this distress, have put up public pumps, and persons whose means permit have put up others, allowing the free use of them to neighbors who were debarred from resorting to the same expedient. Still, as the inhabited portion at a distance from the river is considerable, and the erection of pumps has been limited to the central part where the population is denser and the supply greater, the result has been that the families in the more distant portions from the center have had to emigrate, abandoning their homes, and suffering losses which in many cases have amounted to complete ruin.

All this injury is without natural cause. The river has enough water in its upper part, and that water would suffice if the one-half secured to us by treaty was allowed to run down to the frontier, but such is not the case. Irrigation companies have been formed in the United States, which take the water of the Bravo to irrigate the lands of Colorado and New Mexico, intercepting it altogether, leaving the river dry in the part which divides New Mexico from Texas, and afterwards separates the latter State from our Republic.

The inhabitants of Texas have already taken pertinent steps, asking the protection of their General Government, in order that they may in some way receive the water for the fertilization of their lands. They ask this as a favor, since the public lands of Texas belong not to the Federal Government, but to the State.

We must ask the same, not as a favor, but in virtue of the duty incumbent on the American Government *according to existing* treaties to turn over to us one-half

of the water which the river naturally contains, which half has been unduly seized by citizens of that country, with the authorization and protection which the authorities have been obliged to give to those enterprises.

With this object, the inhabitants of this locality have raised a protest, which under the conduct of local and State authorities is already operative, in the hands of the secretary of relations, in order that the secretary shall make due reclamation to the Government at Washington.

In order to carry out practically the restitution which we claim, we have thought of means that may be employed. At first sight the most natural means seems to be to cause the waters now diverted to return to their natural channel; but since considerable interests have already been created by the irrigation companies to which we have referred, and since it would not be equitable to take from one an advantage which may be given to another by other means, we agree, both the citizens of El Paso, Tex., and those of this place, that the radical remedy lies in the realization of the Mills project at the expense of both nations and according to proper preliminary treaty. This project consists in the construction of a conduit 60 feet above the mean height of the water, which within the river channel is to close up the space between the bordering hills. Behind this conduit there is an extensive valley with very gentle slope, which is to be filled to an extent of 26,300 acres to a maximum depth of 3 feet 8 inches. Adopting a mean depth of 1 foot, the capacity of the lake is found to be 532,000 acres. The mean volume of the river is calculated at 1,200 cubic feet per second, of which we would be entitled to one-half, or 600 cubic feet per second, at a height of 50 feet on issuing from the conduit. This would yield a motive power of 3,381 horses constantly at work, or 10,143 horses working only eight hours a day, an enormous quantity, which will give rise to the establishment of new industries. This consideration alone should suffice to determine the execution of a work which is to produce so great an improvement.

At present there are irrigated and cultivated from 25,000 to 30,000 acres of ground, and inspection of the ancient works still existing assures us that by the new canal that is to issue from the projected conduit there might be irrigated 100,000 to 125,000 acres continuously, and without fear of the river's failure at any time.

Among other advantages of the project is this, that the outlays and labors will cease which the municipality and the population are constantly obliged to make in the repairs which the conduit requires.

But the great international importance of the work and the real advantage for the two nations lie in the fact that the dividing line marked by the river will never more undergo change up to the mouth of the river Conchos at Presidio del Norte, because its water being distributed in the American and Mexican irrigation canals, no more will be allowed to run in the river than the quantity necessary for the needs of the riverain towns farther down, the channel being rectified and a true canal being formed which will be invariable, and will smooth over the questions now existing concerning the proprietorship of the ground left by the river on one or the other side of its banks.

On the American side the preliminary steps have already been taken to insure the appropriation by Congress of the sum necessary to accomplish the work. The locality has been visited and all the pertinent data have been obtained by the Senators forming the Irrigation Commission, the deputy for the State of Texas, and the Chief of the Geological Survey. Engineers, topographers, hydrographers, geologists have come and surveyed the topography and made hydrographic and geologic studies, and have completed the project of the work, calculating its cost, including indemnity for the ground to be occupied by the two railways whose location will have to be changed.

All persons that have come to study the case are unanimous in their opinion that the primordial right of Mexico given by treaty is unquestionable. They further agree in holding that since Mexico made no objections after the annexation of Texas to the United States to the construction of conduits by Americans for the purpose of taking the water which they have used since that time for the irrigation of the new American territory, without having a share in the expenses of construction, reconstruction, and constant repair, she has thus acquired, in view of her generosity, and of the indemnity which she may claim for the damage she has suffered and will continue to suffer, by the occupation of waters which are her property, the moral right of not being called upon to bear one-half of the total cost of the work, but only one-half of the total cost of the wall or work of masonry. The total cost of the work will be $1,000,000, and the cost of the wall $300,000. Thus the Mexican Government would obtain for $150,000 all the advantages we have enumerated.

It is safe to say that our Government will not hesitate to make the reclamation, carry out the treaty, and vote the sum required; but the situation in which we are now placed is unbearable, and we need prompt remedy. Hence it is imperative that our petition, in the hands of our minister at Washington, shall be made efficient at the next meeting of the American Congress in the coming December, in order that *that Congress, during its* coming session, may appropriate the necessary sum for the

work; and it is requisite that the indemnity be demanded by our Government, since the State of Texas may be denied what it asks as a favor, while our nation can not be denied what it asks as an indisputable right.

Hence it behooves to agitate without a day's rest, for the dispatch of the protest raised by the people of Ciudad Juarez, in order that our reclamation may arrive at Washington during the first days of the coming December in due form and through the proper channels.

This is the favor we ask and hope of you, trusting in your patriotism and in the interest which you bear this part of our territory.

We tender you in advance the most sincere demonstrations of our gratitude, and assure you of our particular and distinguished consideration.

Ciudad Juarez, November 21, 1889.

DÁMASO SANCHEZ,
President.

IGNACIO GARFIAS,
Secretary.

To the Messrs. Deputies in the Congress of the Union,
C. JESUS VALENZUELA, C. MANUEL RINCON, C. MARCELO LEON,
Mexico.

REPORTS OF MILITARY OFFICERS STATIONED ON THE RIO GRANDE FRONTIER, DEPARTMENT OF TEXAS.

CIRCULAR OF INQUIRY.

The following inquiries were made by circular issued from Army Department Headquarters at San Antonio, Tex., in response to the request of the chairman of the committee, made through its engineer expert, Mr. R. J. Hinton.

(1) What system of irrigation is used in your post or in the vicinity thereof?
(2) What is the source of water supply?
(3) What is the quantity of water-supplied?
(4) What is the area of land irrigated?
(5) What is the length of main ditch.
(6) What is the length of secondary ditches?
(7) What was the cost (approximate) of putting in the system?
(8) What was the value of the land irrigated per acre before irrigation was put in?
(9) Value after irrigation?
(10) Does the system belong to the land-owners or is it the property of a separate company?
(11) What is the cost per acre per year for irrigation?

STATEMENT OF W. C. BORDEN, CAPTAIN AND ASSISTANT SURGEON, AND D. J. RUMBOUGH, FIRST LIEUTENANT THIRD ARTILLERY, U. S. ARMY, OF SAN ANTONIO, TEX.

The only method used in this department is that known as bed-work irrigation. In this method the water is conducted from the source of supply by means of a main ditch and furnished to the land by means of secondary ditches. The inclosed map of the San Felipe ditch gives a good idea of this method, and the statement made by the owners shows the great advantages derived from irrigation.

This ditch was constructed by a company, each member of which had to own land on its line. In case of sale, the water privilege is transferred with the title. The total extent of land irrigated is about 7,000 acres, being ordinary river-bottom land, such as is found all along the Rio Grande. This land, before irrigation, is covered with mesquite brush and a sparse growth of grass or precarious and scant crop of corn. The ordinary price of this land varies from 75 cents to $2.50 per acre, according to slight differences of soil or proximity to water.

Profitable cultivation of the soil without irrigation is out of the question, as scant crops only are produced, and those only during a particularly favorable season, the seed sown often being entirely lost. In all respects the land irrigated at Del Rio by the San Felipe ditch is a type of the greater part of western Texas, in which there are vast tracts where water only is needed to change the land from barren or grazing land to soil capable of high cultivation.

The San Felipe ditch with its branches, under which 7,000 acres are irrigated, was put in at a total *cost of about $30,000, or about* $4.75 per acre. The land so irrigated,

the highest price of which was $2.50 per acre, is now worth from $45, the lowest, to about $100, the highest, price per acre, a rise in value of from $42.50 to $97.50 per acre, at only an outlay of but $4.25 per acre. This rise in value is entirely due to irrigation, as the land immediately bordering on the irrigated lands is still held at the old price. From this we see that land which was originally worth $17,500 at the highest is by irrigation increased in value to fully $400,000, and that by an outlay of only $30,000, showing the immense gain on the money invested.

The cost of irrigation per year for such repairs and work as are necessary to keep the system in good repair is about 75 cents per acre yearly, varying with the year, being some years as low as 50 cents and others as high as $1.

The increased productiveness of the land can hardly be estimated, as before irrigation it was practically barren, while now grains, grass, and fruit are raised in the greatest abundance, changing what was before only a cattle range into a plain covered with cultivated farms.

It is true that the problem of irrigation at Del Rio was practically an easy one, as the water is derived from the San Felipe spring, so rendering the supply nearly constant and equal in quantity, and if the same conditions obtained in other parts of Texas the cost and trouble of irrigation would be reduced to a minimum. Such is not, however, the case. The rivers of Texas are subject to great and sudden rises, the Rio Grande particularly so, and in addition the bed of the river is constantly changing. The difficulties arising from the sudden rising and falling of the streams can of course be obviated by properly-constructed flood-gates, but the shifting of the river bed offers many and great difficultics, so great in fact that in some cases the engineers have been unable to overcome them.

The subject of irrigation by means of artesian wells is but a repetition of irrigation from streams, provided a sufficient supply of water can be obtained.

STATEMENT OF MAJOR MILL, TENTH CAVALRY, U. S. ARMY, AT FORT BLISS.

I have the honor to return, inclosed herewith, the letter with printed interrogatories, with the answers that suggest themselves to me as being most correct and appropriate to each of the eleven numbered questions, as follows:

To the first: None at the post; in the vicinity, in the valley of the Rio Grande, for 50 miles below, principally on the Mexican side, the old Mexican system of numerous small ditches is still in use.

To the second: The Rio Grande, exclusively.

To the third: Ample for about five years out of each seven, during which period there is one year of drought, when the river goes practically dry and another of great flood, each of which occurrences prevent the cultivation of the greater portion of the improved lands.

To the fourth: On the American side about 6,000 acres; on the Mexican side about 18,000 acres.

To the fifth: One principal about 10 miles, on the Mexican side; on the American side there are some four main ditches taken from the river, ranging from 4 to 8 miles long.

To the sixth: From 500 yards to 2 miles.

To the seventh: These systems are from one hundred to two hundred years old, and were built by a tax on labor, and on which it is impossible at this time to even approximate the money value.

To the eighth: The land was generally granted free, by the Spanish Government, to such as would undertake to put it or a portion of it under cultivation.

To the ninth: Mexicans have no approximate values on real estate; changes in ownership seldom take place as compared with us; if one wishes to sell he takes the first offer, and unless he does desire to sell he will accept no offer whatever; on the American side land under cultivtion is held at from $20 to $40 per acre, some of the same having in the past few years been purchased at from 50 cents to $2 per acre.

To the tenth: So far the systems in each country belongs exclusively to the owners of the land, in community, as public roads do in the States.

To the eleventh: This would be very difficult, even to approximate, the only expense being the keeping the mouths of the main ditches where the water is taken from the river in repair from destruction by floods and the changing of the river, which often takes place, sometimes moving miles in the same year; the annual cleaning of the ditches of a deposit of silt or sediment of from 6 to 10 inches in the bottom and sides of a thick heavy and sticky clay very hard to handle, and the other cares needful to such property, but as they are all carried on by a general pro rata tax on labor the money value can not be satisfactorily approximated even.

STATEMENT OF J. V. LAUDERDALE, MAJOR AND SURGEON, U. S. ARMY, AT FORT DAVIS.

My opportunity for observation is confined to an area of country 30 miles due north of this post, on the road to Victoria, Tex., and south as far as Marfa, Tex. The nucleus of the mountains and high lands in this vicinity, like those of the Rocky Mountains, consist of trap-rock; and their sides are flanked by more or less altered sandstones. The valleys between are filled in with rounded sand and gravel, and beds of clay and alluvium.

In every place that I have visited, where there are springs or perennial streams, large tracts of lands have been supplied with water through irrigation ditches led out from the main source. A few feet of dam thrown up about a spring forms a reservoir which may be made to irrigate miles of land. The main ditch at Victoria carries water over a tract of land 10 miles in extent.

In regard to reclaiming lands that depend upon rains alone for their supply of water, I would say that the only method which has proved to be at all successful to the average ranchman is to widen and deepen existing ravines and catchment areas, and allow them to fill during the rainy season. Water may be removed therefrom by pumping or led out through pipes to the lands below. They afford a supply of water for stock during a good part of the dry season.

All attempts at damming ravines and water-courses with earth and brush is labor thrown away, as the first freshet will wash them out. An instance in point is the efforts of the brothers Merrill, about 12 miles from this post, where, after weeks of labor, they made a dam of earth across an arroyo, about 75 feet in length, 50 feet wide at the base, and 25 feet high. It was made of alluvium and clay. The front of this dam was supported by brush, tree-tops, etc. It is needless to say that the first heavy rain carried everything before it.

Damming ravines or building reservoirs to successfully hold water is quite an expensive undertaking, and can be accomplished only by walls of cut stone laid in good masonry. Examples of this kind of reservoir may be seen at the water-works at Atlanta, Ga.; also at the crossing of the Encarnacion River, on the Mexican Central Railroad. At several points along Lympia Cañon ranchmen have constructed dikes or semicircular mounds to catch the storm-water that descends from the hills, only to see them washed away during a freshet. Tanks, to be capable of holding water, should be dug out of the natural soil or excavated in the rock formation at a suitable height above the lands to be irrigated. The water thus dammed may be tapped through a small gate set in masonry below ground, or removed by siphon or pump, above ground. A waste-gate for the overflow in time of freshet is indispensable in all such reservoirs. Rosebud Cañon and Fraser Cañon are localities that could be cultivated if they had reservoirs to supply them with water.

There is a large tract of land near the village of Marfa, on Southern Pacific Railroad, where water is now only obtained by pumping it from an artesian well and it sells at 20 cents a barrel, that could be provided with a reservoir for the storing of storm-water, and gardens and orchards could be irrigated from it. I am unable to give estimates of costs, etc., as my observations have been made without engineering instruments and I do not know the cost of such a structure. With a mean annual rain-fall of nearly 18 inches I believe that there are many square miles of land in this vicinity that may be reclaimed for agricultural purposes whenever our ranchmen and other citizens shall take steps to preserve the rain-water that now finds its way into subterranean caverns of the earth or by surface drainage into the sea. The elevation of this place above the level of the Gulf of Mexico is about 5,000 feet.

In response to Department questions the replies received are as follows:

E. M. Randall, captain, Fifth Infantry, U. S. Army, commanding at Fort Ringgold, states that there is no irrigation in vicinity of post; the garden at post is watered from works as water can be spared. The source is the Rio Grande River. The water-tanks of post have a capacity of 64,000 gallons. The garden is between 6 and 7 acres. The land on which post is built cost $20 per acre.

From Fort Brown the irrigation of from 2,000 to 3,000 acres is reported on a sugar plantation owned by a Mr. Brule. The main ditch is in length about 2 miles; the ary ones are about 300 yards in length. The value before irrigation was $1 and is now about $20 per acre.

George F. Towle, captain, Nineteenth Infantry, U. S. Army, commanding at Fort Concho, states that surface irrigation exists by water conducted in ditches from low dams in creeks and rivers. The sources are the North, South and Middle Concho Rivers, Dove and Spring Creeks. The average amount of water running in said streams is equal to about 150 to 200 cubic feet *per second*, nearly all which is at present utilized

for irrigation. The amount irrigated is about 7,500 acres. The aggregate length of main ditches, which are in different hands, is about 50 miles; of secondary, 75 miles; approximate cost, about $5 per acre to get the land under water; of land, from $2 to $5 per acre; after irrigation, from $30 to $100, according to location. Most of the systems belong to land-owners; a few only belong to incorporated companies. The cost varies. For one farm of 1,500 acres it has cost $1.50 per acre.

George H. Morgan, first lieutenant, Third Cavalry, U. S. Army, commanding Camp Piña, Colorado, reports that irrigation is by acequia or ditch. Sources are Rainbow Creek and other very small streams. There is about 10 inches flowing, serving 10 acres. The length is one-half mile. The cost in work was eight mules and ten men one day. The value of land is nominal and due to water only. Post garden is made and controlled by troops. One man gardener can generally keep ditch in repair. Heavy rains generally wash all improvements out.

Charles Morton, captain, Third Cavalry, U. S. Army, commanding camp at Eagle Pass, reports post garden under irrigation with success, and watered from town wells and works. He adds that a large irrigating ditch 35 or 40 miles long is being made, to come from near Del Rio to this town. It will reclaim many thousand acres of land.

A. G. Brackett, colonel Third Cavalry U. S. Army, commanding at Fort Clark reports a system of irrigation by ditches, raising water above the bottom lands of stream, through differences in fall; the source is Las Moras Creek; supply is 1 barrel per second, but much more is available; on the reservation about 6 acres are irrigated, which belongs to the United States. Colonel Brackett also reports that at Mud Creek, about 16 miles west of Fort Clark, there is a gravity system by means of ditches, supplied from Mud Creek; it supplies about 1 barrel per second, irrigating 600 acres by a main ditch about 3½ miles long; secondary ditches are short and in all about 3 miles in length; system cost $2,500; before irrigation land was worth $2 per acre; after it at least $50; the system belongs to the land owners; the cost of irrigation is about $2 per acre, including repairs to main ditch.

At the mouth of the Pinto, about 18 miles southwest from Fort Clark, there is a system of ditches supplied from Pinto Creek. At its mouth the Pinto flows about 4 barrels per second; there are about 200 acres under irrigation; main ditch is 2 miles in length; secondary ditches are short, about 2 miles in length; cost is $2,000; value of land before irrigation $2 per acre, after about $50 per acre; the system belongs to the land owners; the cost is about $2 per acre, including repairs to main ditch.

At Dolores, Kinney County, there is a system of irrigation by ditches. It is about 8 miles south from Fort Clark, and is supplied from Las Moras Creek; all the water is used, affording a flow of about 3 barrels per second, serving 1,000 acres; the main ditch is 2¼ miles in length, and secondary ditches are about 2 miles; system cost $1,400; land was valued at $2 per acre; now at $50; ditches belong to land owners; system cost about $2 per acre, including repairs to main ditch.

At Mariposa there is a system of irrigation by ditches; location is about 7 miles northwest from Fort Clark; served by Pinto Creek; the cross-section of water in the ditch is 1 foot by 3 and the current is 3 miles per hour, giving a flow of about 1 barrel per second; the main stream is much longer; it serves 600 acres; main ditch is 3 miles, and secondary ditches are short, their aggregate length being not greater than that of the main ditch; the cost was $6,000; land value before irrigation $2 per acre; after, $50 per acre; the system belongs to the land owners, and the cost was about $2 per acre, including repairs to main ditch.

STATEMENT OF B. K. BRANT, SECRETARY OF THE PIONEER CANAL COMPANY.

IRRIGATION IN THE PECOS VALLEY, TEXAS.*

Irrigation in Texas is of comparatively recent date. With the exception of a few canals in the valley of the Rio Grande, the irrigation in Texas dates subsequent to the year 1875. In that year the legislature of the State passed an "act to encourage the construction of canals for navigation and irrigation," and for that purpose made donations of land to any company incorporated under the laws of the State, constructing canals of the several classes named in the act.

Encouraged by this law a few ditches were taken out of the smaller streams tributary to the Pecos River, where it could be done at a small expense. Being so far removed from market at the time, from lack of railroad facilities, and the country being sparsely settled, the cost of building and fencing material so great, that the lands offered by the State as an "encouragement" proved but a slight inducement to the practical irrigator.

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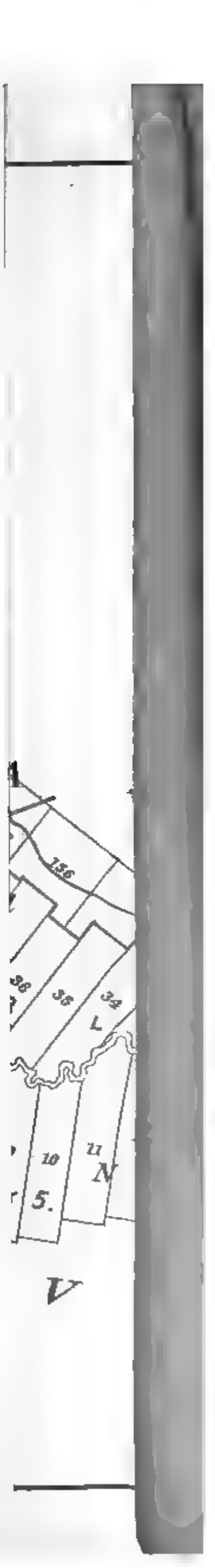
* *Referred to in Mr. Brant's testimony in the Staked Plains Division.*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Under the law of 1875, however, there were constructed several canals in Reeves (then Pecos) County. Among them may be mentioned the Rooney Ditch, taken out of the Pecos River about 25 miles south of the present site of Pecos City. This was the only ditch taken out from the Pecos River under that law. From Toyah Creek, a tributary of the Pecos River, in said Reeves County, there were taken out several ditches of the third class, to wit: The Saragosa Manufacturing and Irrigation Company's ditch, capacity 6 feet on bottom, 2½ feet deep, and 3 miles in length; the Murphy, Syles, and Miller ditches, of similar construction and capacity. On each of the ditches, since their construction, have been grown a variety of grains and grasses, of large yield. The law, however, proved inadequate, and offered but little encouragement to investments in irrigation canals.

At a State convention, held in the city of Dallas in August, 1888, a resolution was adopted calling upon the legislature to pass some law for the encouragement of irrigation in the State. Responsive thereto the legislature formulated the present law, which will probably prove the one thing needful. The principal thing sought for in legislation is the needed protection to the appropriator of water. Priority of appropriation gives priority of right. That once secured, the rest of the legislation follows as a natural sequence. The same legislature passed the following resolution, calling the attention of the Texas Senators and members in Congress to the needed legislation on the subject of the right to the use of water in interterritorial and State streams. Such legislation by the General Government is very much needed, and should be based on the principle that priority in time of appropriation gives priority of right.

"Whereas several rivers having their sources in New Mexico and other Territories flow into and through the State of Texas; and

"Whereas the waters of said streams are necessary for irrigation in the arid districts of Texas; and

"Whereas it is expedient to obviate future litigation by providing for an adjustment and regulation of the rights of the respective citizens of said Territories and said State of Texas, entitled to the use of said waters for purposes of irrigation: Therefore, be it

"*Resolved by the legislature of the State of Texas*, That our Senators and Representatives in Congress be requested to secure the passage of such laws as may be necessary to effect the objects above set forth."

Encouraged by the legislation on the subject of irrigation, the Pioneer Canal Company, in the year 1888, commenced the construction of a canal on the Pecos River.

This canal is taken out on the west bank of the Pecos River, in Reeves County, Tex., about 9 miles north of the town of Pecos City.

The water is brought to the surface at the distance of about 3½ miles, where the main stem is divided into two canals, the east and the west valley lines. The former is then flumed over the river and serves the large valleys on the east bank of the river. The latter continues its course on the west side, crossing the track of the Texas and Pacific Railroad at the town of Pecos City.

The main canal, 7 feet deep, and 44 feet at the water surface, is 23 feet wide on the bottom, and carries 1,020 cubic feet of water per second of time, a quantity of water sufficient to irrigate 64,000 acres of land.

The two lines of the canal when completed will be 52 miles in length, of which 14 miles have already been completed. (Date of writing September 16, 1889.) The west valley line will be completed back to the river, a distance of 20 miles from the head-gate, by the 15th of November, 1889.

Work was begun on this canal in the month of April, 1888, and is being rapidly pushed to completion. The canal covers very fine bodies of land on either side of the river. Quite a number of small farms under the canal have already been opened, and there have been raised Indian corn, 35 bushels per acre; millet, 2½ tons per acre; sorghum, 6 tons first cutting, with a heavier crop promised for the second cutting; sweet potatoes very prolific, not yet dug; heavy crops of all kinds of melons, squash, beets, turnips, and general garden vegetables. Nothing was planted earlier than the 15th of June, owing to the fact that the canal was not sufficiently completed to furnish water for irrigation before that date. All lands were sod, being first grubbed and broken in May of the present year. This year's experiments in planting alfalfa has demonstrated the fact that alfalfa should be planted not earlier than the 1st of September, and may be planted until the 1st of November. It may also be sown in the spring with success from the middle of February until the 1st of April. Between the seasons indicated the sun is too warm for so tender a plant to get a good start. Once established alfalfa thrives in warm weather.

A large acreage of orchards will be planted this fall.

All kinds of deciduous fruit trees, English walnuts, soft shell almonds, French prunes, and a large variety of European grape vines, of which there is not the least doubt of the success of their cultivation, as they have been successfully grown near this point by irrigation. Under the canals on Toyah Creek, and on the Pecos River,

in this county, have been grown large yields of rye, barley, oats, Indian corn, and wheat, a fair average of which would be for rye, 30 bushels per acre, worth $1 per bushel; barley, 50 bushels per acre, worth for feed $1 per 100 pounds; oats, 70 bushels per acre, worth unthrashed, $15 per ton; corn, 40 bushels per acre, worth 65 cents per bushel; wheat, 35 bushels per acre, worth $1 per bushel; alfalfa, 10 tons per acre, worth $18 per ton; millet, 3 tons per acre, worth $15 per ton; sorghum, 12 tons per acre, worth $15 per ton.

The Aztec Irrigation Company, incorporated in July, 1889, will also begin operations on Toyah Creek and be prepared to deliver water to consumers for the spring crop of 1890.

Flowing artesian wells, ten in number, inside the corporate limits of Pecos City, flow nearly, if not quite, 50,000 gallons of water per hour, and is used exclusively for drinking, washing, and all domestic purposes, including irrigation. As the wells have a natural pressure that forces the water 30 feet above the ground, they can be used for fire purposes. The artesian water belt in the Pecos Valley country is practically without limit, and can be utilized to irrigate thousands of acres at a moderate cost. A well that will irrigate 20 acres of land can be had, including the best of iron casing, at $300 to $400, and at a depth of 200 to 250 feet.

Climate.—Our winter climate is simply delightful—clear, bright days, with the thermometer rarely below the freezing point; very seldom rain, snow, or sleet; no "northers" or "blizzards," such as are common in eastern Texas and other States. In summer, owing to our altitude, 2,700 feet above sea-level, we do not have as warm weather as other points east of us in the same latitude. While the weather gets hot in summer, and the sun is brighter, apparently, than at most other localities in the State, the thermometer (in the shade) rarely reaches 100 degrees, and the nights are always cool and refreshing—never too warm to sleep well.

Rain-fall.—Our annual rain-fall is from 12 to 18 inches.

Soils.—Soils of the Pecos Valley under the Pioneer Canal are considerably diversified, there being the black and chocolate colored stiff lands, and sandy loams, varying in color from black to red. There are also about 5,000 acres of a peculiar whitish loam, and from the amount of silica and lime it contains it will certainly prove valuable as grain, alfalfa, and fruit lands.

Price of lands in the Pecos Valley.—There are a large number of sections of State school lands on the Pecos River under the Pioneer Canal, which alternate with various railroad surveys. These lands are offered by the State at $3 per acre on forty years' time, with 5 per cent. on the deferred payments.

The railroad lands are offered at correspondingly low prices—one-fourth cash, and balance in one, two, and three years.

Water-rights.—A Pioneer Canal permanent water-right is an amount of water for 40 acres of land, equal to an annual rain-fall of 40 inches, distributed under a head of 100 miners' inches. A 40-acre water-right is sold for $300.

This company is most liberal in taxing the land for water service, charging $1 per acre for the land in cultivation.

Analysis of soil.—An analysis of the soil of the Pecos Valley shows the following percentages:

Organic and volatile matter	6.73
Insoluble residue	76.97
Soluble silica	.14
Iron	3.13
Aluminia	2.07
Phosphoric acid	.21
Lime	5.22
Magnesia	Trace.
Sulphuric acid	.87
Alkalies (as chlorides)	2.27
Carbonic acid	3.22
Chlorine	.07
Total	100.90

Analysis of Pecos River Water.—An analysis of the water in the Pecos River shows the following percentages:

Suspended matter	36.32
Total solids in clear solution	308.48
Organic and volatile matter	53.00
Total mineral matter	255.48
Total soluble matter	172.59
Total insoluble matter	135.89
Total hardness	27.42

Temporary hardness	4.05
Permanent hardness	23.37
Sulphuric acid	64.57
Alkalies (as chlorides)	58.70
Chlorine	39.05

MEMORANDUM OF IRRIGATION CANALS OF THE PIONEER CANAL COMPANY IN REEVES AND WARD COUNTIES, TEX.

Head gates on west side of Pecos River, 9 miles above Pecos City.

	Miles.	Feet.
Length of main line	3	160
Length of east valley line	34	.....
Length of west valley line	14	1,473
Total miles	51	1,633

Main line:

Width at bottom	feet..	23
Width at surface of water	do...	43
Depth	do...	7
Carrying capacity per second	cubic feet..	1,020
Miles of water-ways now complete	miles..	19
Land susceptible to irrigation	acres..	64,000

Work commenced April, 1888.

Quality of land.—Alluvial, and chocolate-colored and black sandy loam; products are the serials, alfalfa, the deciduous fruits, raisin grapes, and all varieties of European grapes, French prunes, English walnuts, and soft-shelled almonds———

STATEMENT OF THE PECOS RIVER IRRIGATION COMPANY, PER O. W. WILLIAMS, PRESIDENT.

The officers of the company are O. W. Williams, president; T. J. Ray, secretary; A. P. Wooldridge, treasurer. The principal office is at Fort Stockton, Tex. This company possesses an old canal, built in 1878, 9 feet wide, 3 feet in depth, carrying 65 cubic feet of water per second of time, and supplying 5,000 acres of land. The head gate is at Ripples, 30 miles southeast of Pecos City. The canal is now being enlarged and extended. Where the enlargement is completed, the canal is 25 feet wide by 3½ feet in depth, carrying 250 cubic feet of water per second. The canal is now 10 miles in length, and covers 8,000 acres of good land. Work is progressing, and it is intended to make the canal finally 30 miles in length, 40 feet in width, 4 feet in depth, with a capacity of 500 cubic feet of water per second of time. Work progresses at the rate of 1½ miles per month. Water rights are held (permanent), at $2.50 per acres, subject to annual assessment for the necessary repairs, etc., incident to keeping the canal in good condition.

There are some places along the canal where good storage can be had.

NEW MEXICO DIVISION.

SANTA FÉ, N. MEX., *September* 7, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

Members of the State constitutional convention were examined.

STATEMENT OF W. H. H. LLEWELLYN, OF LAS CRUCES, N. MEX.

The CHAIRMAN. How long have you resided in Las Cruces?

Mr. LLEWELLYN. For the past five years.

The CHAIRMAN. Have you given attention to the subject of irrigation?

Mr. LLEWELLYN. Yes.

The CHAIRMAN. And of water-supply in this Territory?

Mr. LLEWELLYN. Yes.

The CHAIRMAN. Will you state the condition of your county, and any other portions of the Territory with which you are familiar? State what you have now, the supply of water you have, and what are the prospects of reclaiming land there.

Mr. LLEWELLYN. The lands in the Mesilla Valley, in Doña Aña County, are irrigated by canals which take the water from the Rio Grande. We have now under cultivation in the Mesilla Valley, in the vicinity of Las Cruces, about 20,000 to 25,000 acres of land. There is, however, a large tract of land there which, with proper arrangements for the storage of water, is equally good with the lands now under cultivation, and which could be brought under cultivation—probably about 200,000 acres.

The CHAIRMAN. From where would you obtain the water?

Mr. LLEWELLYN. We would obtain the water supply from the Rio Grande.

The CHAIRMAN. How would you be required to do it?

Mr. LLEWELLYN. We would do it by the construction of a canal at a point probably about Socorro, and probably as far up as Las Cruces, which would carry the water on to the tract of country known as the Jornado del Muerto, and this canal, if built, would cover in addition to the land I have mentioned before 200,000 acres of land, and other tracts of very rich land, which are now valueless on account of having no water.

The CHAIRMAN. Is there sufficient water in the river to supply the needs?

Mr. LLEWELLYN. There would be an abundance of water by the construction of proper reservoirs.

The CHAIRMAN. What is the condition of the water at flood-time? You have not gauged it?

Mr. LLEWELLYN. There is an enormous quantity of water that annually passes down the Rio Grande early in the spring.

The CHAIRMAN. That goes to waste?

Mr. LLEWELLYN. Flows absolutely to waste, to the Gulf?

The CHAIRMAN. Have you had any surveys or estimates of this plan of this stream?

Mr. LLEWELLYN. Yes, there has been an accurate level line run and survey made.

The CHAIRMAN. Have you a report of it?

Mr. LLEWELLYN. I have not with me. I have it in my valise.

The CHAIRMAN. Will you furnish a report of that?

Mr. LLEWELLYN. I will. I will be glad to hand it in.

The CHAIRMAN. Are you acquainted with other portions of the Territory?

Mr. LLEWELLYN. Yes; I am acquainted with every portion of New Mexico by personal observation.

The CHAIRMAN. Describe any other portion with which you are specially familiar.

Mr. LLEWELLYN. By describing one particular tract or section of country it will be applicable to all portions of the Territory. There are in New Mexico numerous water-courses which, during a high stage of water carry an immense volume of water, which passes away, and later in the season the streams are nearly dry. By the construction of reservoirs this water could be stored, and thousands of acres of valuable land could thereby be brought under cultivation.

The CHAIRMAN. If the Government would make the necessary surveys and investigations to show what could be done, with estimates of cost, would that be of any advantage to your people here?

Mr. LLEWELLYN. It would be a great advantage.

The CHAIRMAN. Are there many places where private capital or by association of capital they could construct the works?

Mr. LLEWELLYN. There are many places where private capital is now constructing irrigating-canals.

The CHAIRMAN. Describe some of them where private capital is now engaged and what the plans are, if you are familiar with them?

Mr. LLEWELLYN. In the Maxwell land grant, in the northern part of the Territory. This land grant company during the past year constructed a number of irrigating-ditches, and in connection with the irrigating-ditches have constructed reserviors to store water. In the lower valley of the Pecos, in Lincoln County, there are three large canals now in process of contruction by private capital. But these two localities are especially well situated for private capital to carry out this work, more so than any other places in the Territory.

The CHAIRMAN. Have you in Mesilla Valley, or anywhere else, given special attention to the quantity of land that an ordinary family, a man and wife and two or three children, can cultivate profitably by irrigation?

Mr. LLEWELLYN. Yes; I have myself personally.

The CHAIRMAN. Without hiring help?

Mr. LLEWELLYN. Without hiring help.

Mr. CHAIRMAN. How much land would they need?

Mr. LLEWELLYN. In my opinion a family is much better off in Mesilla Valley if they intend to cultivate the land themselves, with part in al-

falfa and part in fruit, to have not to exceed 15 or 20 acres. That is as much as a family can take care of.

The CHAIRMAN. What occurs in this Territory when they undertake to irrigate too much land as a general thing?

Mr. LLEWELLYN. It generally occurs that they make a partial failure of it; their crops are not so good. In other words, 10 acres of land properly cultivated will produce more than 40 acres indifferently cultivated and irrigated.

The CHAIRMAN. The land in this Territory wants to be cut up into small farms?

Mr. LLEWELLYN. That is my opinion—to have irrigated lands cut up into small allotments.

The CHAIRMAN. What schemes have these companies that are bringing out water adopted for disposing of the water?

Mr. LLEWELLYN. There are several different plans. The plan of the Pecos Irrigating Company is to charge $15 per acre for the water-right that is attached permanently to the land. They then charge an annual rental thereafter of $1.50 an acre. They divide, however, this $15 into annual payments. There is another company down there that charges $10 an acre and divides that payment into ten annual payments, and then it charges in addition to that $1.50 an acre for the water.

The CHAIRMAN. Have any of them adopted the plan when they have paid for the water of turning the establishment over to the settlers and allowing them to take care of it?

Mr. LLEWELLYN. I do not understand that they have. There may be companies in the Territory organized under that plan, but I do not understand so.

The CHAIRMAN. That plan, I would suggest, has worked best in California. The colonies will come in more readily if they can have the entire property.

Mr. LLEWELLYN. Yes; and I understand that is carried out very successfully in Idaho and Utah.

The CHAIRMAN. In Utah the settlers more readily take hold of it if they are to have ultimately the property in hand. In fact, they could not do it individually, and are willing to pay a good price, but want the title absolutely in their hands.

Mr. LLEWELLYN. The ditches we have in the Mesilla Valley are community ditches.

The CHAIRMAN. How are they managed?

Mr. LLEWELLYN. Under Territorial statutes. In January next we elect three water commissioners for the ditch system, and we also elect a major-domo, or overseer of the ditches. And we have what we call repartidors, who act under him.

The CHAIRMAN. Then persons are not allowed to measure out their own water?

Mr. LLEWELLYN. No; it is done sometimes, but only by common consent, and where there is an abundance of water. But the major-domo has general supervision of the ditch.

The CHAIRMAN. You elect him every year?

Mr. LLEWELLYN. Yes; it is done under provision of the Territorial Statutes.

The CHAIRMAN. That is practically an adoption of the Spanish custom and law.

Mr. LLEWELLYN. Yes; it is practically the old Spanish way.

The CHAIRMAN. How long have the lands in this Territory been cultivated by irrigation?

Mr. LLEWELLYN. From a period extending back, probably, three hundred years; that is, since the Spanish invaders occupied the Territory, and perhaps many hundreds of years before that.

The CHAIRMAN. They found irrigation practiced here?

Mr. LLEWELLYN. Yes.

The CHAIRMAN. Have you in this Territory many of the ruins of ancient irrigation works?

Mr. LLEWELLYN. Yes; a number.

The CHAIRMAN. How extensive are they, and what are their character?

Mr. LLEWELLYN. There are the ruins known as the Gran Quivera. They are situated in the eastern part of Valencia County. There are the remains of a system of very extensive ditches there; they have been cemented and plastered. You can trace them for miles.

The CHAIRMAN. The cement still remains therein?

Mr. LLEWELLYN. Yes.

The CHAIRMAN. Still in a pretty good state of preservation?

Mr. LLEWELLYN. Yes; but the water has disappeared entirely.

The CHAIRMAN. Do you know where they got the cement?

Mr. LLEWELLYN. No.

The CHAIRMAN. That was before the Spaniards came?

Mr. LLEWELLYN. That was before the Spanish occupation.

The CHAIRMAN. Have you any material for making hydraulic cement?

Mr. LLEWELLYN. Yes, it is made near Springer; it is of very good quality, and it can be manufactured at other places.

The CHAIRMAN. You do not know where they got theirs; that is to say, those ancient irrigators?

Mr. LLEWELLYN. No.

The CHAIRMAN. It is real hydraulic cement?

Mr. LLEWELLYN. Yes; and it stands there to-day in a very good state of preservation. Coronado, in his first occupation of this country, describes the ruins in Salt River Valley and elsewhere, both here and in Arizona. They have been found at Casa Grande, and at La Tempe, where the ancient canals were constructed.

The CHAIRMAN. Have you any further statement that you desire to make?

Mr. LLEWELLYN. Well, I differ somewhat from some of our friends with reference to the real cause of the low state of the water in the Rio Grande. I do not think it is attributable altogether to the diversion of the water in Colorado. We have had two years of very low stages of water, and I think it is largely due to the fact that we have not had a regular snow-fall on the head-waters of the Rio Grande. But that does not do away with the Government taking active measures to afford us relief, because new lands will be opened up in New Mexico that will get the water off further below.

The CHAIRMAN. When these schemes, of which you speak, are carried out, the water will be largely used above here?

Mr. LLEWELLYN. Yes.

The CHAIRMAN. Has there been a rain-guage kept in this Territory for any considerable length of time?

Mr. LLEWELLYN. There has been.

The CHAIRMAN. Have these dry seasons appeared before, coming in cycles?

Mr. LLEWELLYN. As I understand, the periods of drought in Arizona *in recent years, that is*, very low stages of water in the Rio Grande, were *in 1872, 1879, last year*, and this year.

The CHAIRMAN. I suppose old residents here will recollect other periods.

Mr. LLEWELLYN. Perhaps so.

Senator REAGAN. What is the character of the crops that you raise about Las Cruces?

Mr. LLEWELLYN. We raise corn, oats, rye, barley, wheat, and various varieties of sweet potatoes. We raise nearly all the fine European varieties of grapes, and in fact all the fine fruits.

Senator REAGAN. Will you state the amount per acre of these crops that can be raised on irrigated land.

Mr. LLEWELLYN. If we have the water we can cut four crops of alfalfa, with an average of a ton and a half to the cutting. Five crops have been cut, but four is a very safe estimate. Our vineyards will produce from 16,000 to 24,000 pounds of grapes to the acre.

Senator REAGAN. How much wheat?

Mr. LLEWELLYN. I have known personally of one small crop which produced 42 bushels to the acre.

Senator REAGAN. What would be the general average there?

Mr. LLEWELLYN. I think it is safe to say, with an abundance ot water, good cultivation, and good farming, 40 bushels can be produced?

Senator REAGAN. How much corn do you raise to the acre?

Mr. LLEWELLYN. The corn crop would generally average, under our present system of cultivation, not more than 25 bushels to the acre.

Senator REAGAN. What has similar ground without irrigation produced in that portion of the country?

Mr. LLEWELLYN. Nothing—absolutely nothing.

Senator REAGAN. What you say as to the crops there applies generally throughout the Territory?

Mr. LLEWELLYN. It will apply pretty generally throughout the Territory, except in elevated regions, where the frost might come too early in the fall or too late in the spring. There are a great many sections of New Mexico where it has been demonstrated that all the fine varieties of fruit can be raised.

Senator REAGAN. What kinds of fruit do you raise around Las Cruces.

Mr. LLEWELLYN. We grow dates; pomegranates have been raised; also apricots, pears, peaches, quinces, nectarines, apples, prunes. We have no fruit pests there. Curculio is absolutely unknown.

Senator REAGAN. Can you say anything as to their quality?

Mr. LLEWELLYN. Their quality is reported to be the finest in the world.

STATEMENT OF WARREN BRISTOL, OF DEMING.

The CHAIRMAN. You have resided in the Territory how many years?

Mr. BRISTOL. Ever since the spring of 1872, something over seventeen years.

The CHAIRMAN. You have been United States district judge?

Mr. BRISTOL. For a little over twelve years, not quite fifteen years, continuously.

The CHAIRMAN. Are you a judge yet?

Mr. BRISTOL. No.

The CHAIRMAN. Have you given attention to agriculture by irrigation?

Mr. BRISTOL. A good deal; and since my boyhood I have had an interest in that. I was brought up on a farm.

The CHAIRMAN. Have you pursued agriculture to some extent in this Territory?

Mr. BRISTOL. As far as vineyards, on a small scale, are concerned.

The CHAIRMAN. Where was that?

Mr. BRISTOL. At Mesilla; at present at Deming. I am now living at Deming.

The CHAIRMAN. Have you a water supply at Deming?

Mr. BRISTOL. Yes, but we have to pump it up 50 feet.

The CHAIRMAN. Explain anything you think will be of interest to the committee.

Mr. BRISTOL. So far as my experience in Deming is concerned, it is this: I have bought town lots 25 by 142 feet that, with the exception of my dairy and barn and the rest, are planted in fruit trees. I have a large pump and an 18-foot well in connection with another man. We are supplying water for fourteen or fifteen families, and several gardens are being irrigated from it. My garden is most prosperous, as I give special attention to it. Fruits of all kinds and grapes grow to perfection; the Bartlett pear, and even the peach, the early and late Crawford. This year we have as fine a flavored peach as any coming from the Chesapeake Bay. It was a surprise to me.

The CHAIRMAN. Will you describe that country at the time the railroad was brought there, and before any water was put upon the land?

Mr. BRISTOL. At that time there was no water on this table-land, except occasionally when the water came down by flood. No water was known to exist there, but there is a region of country from 25 to 50 miles wide, and 100 miles long, north and south, that we know of (and how much farther it exists we do not know) where, if you dig down anywhere you will strike water at about 50 feet in inexhaustible quantities. To illustrate, at my place I have a powerful windmill, an 18-inch wheel (Holladay's). Each revolution of that throws out 100 gallons of water. You can run it up to one hundred and sixty revolutions per minute. There are only 2½ feet of water in that well, and that quantity can not be lowered with that pump. It is so all over the plain.

The CHAIRMAN. How did that plain appear before you discovered that water?

Mr. BRISTOL. As a barren plain; a desert with nothing but grama grass growing anywhere on it.

The CHAIRMAN. I thought that was the most unpromising place I ever saw.

Mr. BRISTOL. It was very unpromising. Deming has a great many windmills now, and is a pretty place. The change really seems like a miracle. The Southern Pacific Railroad Company was the first to discover this water beneath the surface. Since then it has improved; the whole plain I have described is covered with cattle ranges, and the ground is all occupied with pumping machinery of this kind to water the cattle. A great deal of money is invested there. The whole plain is taken up.

In addition to that, in the water system to the north of Deming—Cook's Peak mountain, which you probably know—there is one place where the water comes down every year from the mountains, and passes through a range of low hills about 3 or 4 miles from the main chain of mountains. A perfect flood or river of water comes down there every year, several times during the rainy season, and it has dug out im-

mense excavations in the ground. These are filled with water, extending away out on the plain. It is a beautiful plain of the richest soil, and cattle from all over the country frequently, for several weeks at a time, gather in there. That would be a good place at which to build a reservoir, for it would afford accommodation for several thousand acres.

The CHAIRMAN. Then from your observation of New Mexico, are the opportunities for reclaiming land and making homesteads plentiful?

Mr. BRISTOL. Yes, very; especially so along the range of lower mountains and foot-hills. This year has been an exception in some instances, but I have noticed in the extensive range of mountains here that there is rain-fall enough, if it was equally distributed over the plain, to make it one of the most fruitful countries in America. Even in these mountains (a tract that has only recently been discovered) millions of acres may be cultivated without any irrigation, by clearing off the pine forests. In addition to that the great waste of water that flows out from the foot-hills on to the plains could be collected in immense reservoirs and distributed over the plains for agricultural purposes. The opportunities for that are very great.

The CHAIRMAN. What do you say of the climate of New Mexico?

Mr. BRISTOL. I have lived in New York, and I have lived in Minnesota, in the latter State for twenty-five years. I have lived in New Mexico for something over seventeen years, and I regard New Mexico as one of the most healthful climates on the continent. My experience and observation convince me that the most salubrious climate is not high up in the mountains at an extreme altitude, nor down in the river bottoms where they have more or less malaria, but out on these plains where water can be had, and where the breezes blow and there are no malarial influences. I consider this as good a climate as there can be in the world.

The CHAIRMAN. What do you say of the production of crops?

Mr. BRISTOL. I simply say "water is king." Wherever water can be had or can be got on the soil it is wonderful in its productiveness. It is rich in all the elements of fruitfulness, even out on this barren plain that we have been calling a desert. Put water there and everything will grow in luxuriance. On the plains the greatest drawback at present, in my opinion, to successful cultivation is the strong spring winds which obtain in every country where there is no wind-break. As soon as forestry is cultivated here systematically, and trees are planted so as to break the prevailing winds, it will be a wonderful country for productiveness, providing you get water. The altitude of Deming is about 4,000 feet. It is on the first plain out of what we call the Mesa Valley of the Rio Grande. It commences on the Bluffs of the Rio Grande and is a lovely plain all the way on into Arizona.

STATEMENT OF T. B. CATRON.

The CHAIRMAN. Will you please state to the committee any facts of interest that you know regarding this Territory and its irrigation?

Mr. CATRON. I have resided in this Territory for twenty-three years, most of the time at Santa Fé, but part of the time in the southern part of the Territory, where Major Llewellyn resides. What he states about that section of the country is substantially correct. What I can state is, that this Territory is divided, as you observe upon the map, almost equally from north to south by the Rio Grande. On either side of the Rio Grande there is a range of *mountains* extending nearly the whole distance

from the northern to the southern part of the Territory. It extends, with a few breaks only, on the west side entirely through, and on the east side through excepting that due west of here the continental divide is not very high, though a little bit higher than this place. The Rio Grande between the 1st of April and the 1st or middle of July in each year contains almost as much water as the Missouri River does during that period—enough water to irrigate, if properly husbanded and properly divided, at least half of this Territory, if it could be reached—that is, during the crop season. But the Rio Grande is fed by constant streams coming from the mountains on either side. There are also streams on the other side of the mountain running in the other direction. These streams come down very rapidly. There are large quantities of land that it would be difficult to reach from the Rio Grande because they are in cañons. By making reservoirs in those streams (which can be made cheaply) immense volumes of water could be collected in the spring time, as our mountains have from 3 to 10 feet of snow in the winter, and furnish, ordinarily, outside of the Rio Grande, all the water that is furnished for our lands. I do not suppose that more than one-twentieth or one-fortieth of all the land is attempted to be cultivated—probably not more even than one-fiftieth part is attempted to be cultivated—that can be cultivated, for the reason that the people are quite poor and unable to construct reservoirs and extensive ditches. But on all places like that in which you are now, the city of Santa Fé, there are immense bodies of land at the foot of the mountains which can be irrigated, and these streams being deep and being susceptible of damming, can hold a great deal of water. We have hardly enough at this time for our drinking purposes. But the stream above here can be dammed in forty places with dams, some of them not over 40 feet, some 100 feet long. Those would irrigate a great many acres.

The same state of facts exists all along the range of mountains clear up to Colorado on both sides of the river. On the other side of the mountains the same state of facts exists, where the land slopes to the east. There are many fine streams there, which run principally into the Canadian River. Others flow south and run into the Pecos. Much of the land in ordinary seasons can be cultivated without irrigation, but that would not produce over half a crop or one-third. With the assistance of a very slight amount of irrigation, all these lands can be made to produce what would be called a crop in this country.

The CHAIRMAN. Also a variety of crops?

Mr. CATRON. Any variety you can think of. All those uplands will produce wheat, rye, or barley. Corn does not grow so well. It is not so good a crop as the others. Irish potatoes grow in abundance on the uplands, while on the lowlands along the Rio Grande the sweet potato does well. Almost all grapes, except the Mission grape and the El Paso grape, do well. The fruit here, I think, is a better fruit than that on the Rio Grande, while perhaps not so large. Fruit grows excellently here in any place where you protect it.

The CHAIRMAN. How is it with the plains outside the bottom—the lower plains, or what you call the mesas?

Mr. CATRON. This is a mesa around here. These mesas can all be reached by water stored in dams in these mountain streams. The land is very rich and will produce as good a crop as that in the valley of the Rio Grande, if you can get water to it. But I may say nineteen-twentieths can be reached, because under our present system we have not water enough, and the people are not able financially to store that *water.*

The CHAIRMAN. The first thing in order, it seems to me, is a survey and exploration for irrigation purposes only.

Mr. CATRON. Yes; the first thing is such a survey. There is a Government surveying party up this river now. The first thing is to see how much water can be located and the cost of it.

The CHAIRMAN. Do you think, when that is done, that the people will utilize many of the places?

Mr. CATRON. I think a large number of places would be utilized. The fact is, that every day now they are increasing the supply of water by putting in more or less dams or going above and taking water.

The CHAIRMAN. Have they studied the economy of water much in this Territory?

Mr. CATRON. In this place there has been no economy studied at all.

The CHAIRMAN. So that you would not be able to state what would be the duty of water here?

Mr. CATRON. No; I can not state that. I think Mr. Llewellyn has given you the best figures on that. There should also be a big profit wherever a man would take water from any supply that could be furnished from this river. It would yield to the man cultivating the land a large profit over and above what he could realize from that same land without having water.

The CHAIRMAN. How much water would irrigate an acre here?

Mr. CATRON. I could not give you those facts. There are other gentlemen here that can give you the figures.

The CHAIRMAN. About what portion of New Mexico can ultimately be reclaimed by irrigation, according to your best observation?

Mr. CATRON. About one-half of it.

The CHAIRMAN. Do you think so much as that?

Mr. CATRON. Yes.

The CHAIRMAN. About how much of it could be brought under cultivation without resorting to any refined methods, but simply storing and using the ditches without piping?

Mr. CATRON. From one-fourth to one-half of New Mexico can be done in that way.

The CHAIRMAN. By the ordinary methods used in other Territories?

Mr. CATRON. Yes, by the ordinary methods used in other Territories; by taking out these ditches, and probably more after a time by the use of storage. Our railroad transportation here has been so high that we have not been much encouraged. We pay twice as much railroad fare to here from the East as you pay to San Francisco.

The CHAIRMAN. I should think that would impede the growth of the place.

Mr. CATRON. Well, it does not hurry it along any.

Senator REAGAN. Are you familiar with the distribution of the water by irrigation in the valley of the Rio Grande?

Mr. CATRON. Yes, I think I am; that is from observation only.

Senator REAGAN. What measures, if any, have been adopted to prevent the water from going to waste so loosely in the distribution of water in the valley?

Mr. CATRON. There have been no measures whatever adopted when there was a surplus of water to prevent it from going to waste. Each community has taken out a ditch from the Rio Grande, and run out sometimes around the foot-hills, and sometimes around their land just high enough to get it on their land, and they have used all the water sufficient to irrigate their land, and they let the balance go.

Senator REAGAN. *Is that allowed* to run to waste from the end of

the ditch, or do they shut it off so as to allow the water to continue to run in the river?

Mr. CATRON. Sometimes they let it run off, and sometimes they turn it back into the river at the end of the ditch.

Senator REAGAN. Have you no legislation controlling that?

Mr. CATRON. No.

Senator REAGAN. It is one of the great problems here to save that water?

Mr. CATRON. I understand, of course, that that water goes back into the river at the end of the ditch.

Senator REAGAN. Is it your observation that the water is used with due reference to economy and to the interests of the people alone?

Mr. CATRON. No; in taking out their ditches they do not pay much attention to the people below. They take out their water and let the people below look out for themselves. The system of irrigation is very crude.

Senator REAGAN. It is a subject very well deserving the attention of the Territorial legislature.

The committee then took a recess until 3 o'clock, when it again convened.

STATEMENT OF ARTHUR BOYLE, OF SANTA FE.

The CHAIRMAN. How long have you resided in Santa Fé?

Mr. BOYLE. Nine years.

The CHAIRMAN. Have you given any attention to the subject of irrigation?

Mr. BOYLE. I have been raising fruits and crops by irrigation since I came here.

The CHAIRMAN. Tell us where you pursued that business and with what success?

Mr. BOYLE. I lived for three years in the extreme northern part of the Territory. I was farming and ranching there. I found that land which without irrigation barely raised a half a ton of natural grass to the acre produced with irrigation at the first crop 60 bushels of oats and 42 bushels of wheat. Corn does not do very well; still I did raise a very satisfactory crop of corn. The same land without irrigation would be comparatively useless. Since I came to Santa Fé I have given my attention principally to the cultivation of small fruits and the orchard business generally.

The CHAIRMAN. Give us your experience with that?

Mr. BOYLE. The land I took was a very poor cornfield, that scarcely returned seed from one season to another. Last year the trees planted in 1882 gave me a profit of over $1,800.

The CHAIRMAN. For how much?

Mr. BOYLE. For 2½ acres of land.

The CHAIRMAN. What kind of fruit were they?

Mr. BOYLE. Small fruit, such as apples, pears, plums, grapes—in fact, everything that I have tried here up to the present time, where water is sufficient, has succeeded. Under the very common, careless, and ignorant method of irrigation in use here now, land which was scarcely worth cultivating produces good crops. I have put in orchard trees that are thriving very well, and in five years' time from the present spring I think that they will bring me from $300 to $500 an acre.

The CHAIRMAN. Profit?

Mr. BOYLE. Profit. I have seen a great deal of country that is very similar to New Mexico, both as to soil and climate—particularly some portions of Spain and the Nile—great portions of Australia, some portion of the steppes of the Danube, and they are very similar to the land here. In all these places where water is not systematically used the land may be called waste; whereas with a proper application of water there is no richer land in the world. I think it safe to say that New Mexico can easily anticipate an increase of five times her present population within ten years if the storm waters that fall naturally be saved and used for the purpose of turning the water to the best advantage.

We have an annual rain-fall of which the Government has full reports. On the brightest days in July, August, or September, a storm will burst in the mountains, and the water will come tearing down the streams and practically run to waste. It often comes when the crops need it, but it goes to waste. If that water can be saved, it can be made advantageous instead of mischievous, and be made to support a large population. In this particular locality and north of here much of the land which at present is used for pasturing sheep, either because it is too high above the river or because the water in the river is already taken out by riparian occupants, can be supplied with water, and there is water enough for it to depend upon an average crop. Of course virgin soil in the first year would give a heavy crop, but I think an annual crop could be had of from 30 to 35 bushels of wheat, judging by my own efforts, and 40 to 45 bushels of oats. Some portions of the upper part of the Territory would not do so well, but the greater part would give 20 to 25 bushels of corn to the acre. There are other crops that are raised here, such as onions, that are not equaled in any other part of the world except Spain. The onion crop in New Mexico, with water sufficient to apply at the right time, could be made sufficient to supply the whole of the United States. I am stating that, after having made considerable inquiry about it, and giving statements to the freight agent of the Atchison, Topeka and Santa Fé Railroad on this very subject. So I think it is correct. Other things naturally, as the land came in cultivation, would be found suitable for this particular climate and soil, which at the present time we do not raise but look upon as commercial products.

I alluded just now to Spain. Of course, these people are Spanish people, and derive many of their ideas of irrigation from the country from which they came. But they have either forgotten or never knew the improved methods of irrigation in use in the old country. Water here does not serve for 1 acre where there is an abundance for 5 acres. That is so for many reasons. In the first place, each man looks for water only for himself, and does not think of his neighbors. He has practically no control over the waters. Consequently much water goes to waste. The ditches are improperly and badly constructed, and are not kept in repair. I believe that at the present time the establishment of a proper and efficient system of storage reservoirs is of very much more importance to this section of country than any other question which we have before us at the present time. A new population is coming in at the headquarters of all our streams. Colorado is diverting a great deal of water from this country that the people of this country have depended on in years past. Not only the Rio Grande, but the other streams—the headquarters of the Pecos and other rivers in southern Colorado—are now being used at their sources, and therefore when a flood occurs it is turned *off on the land*, and the people living below

along the course of the river are deprived of water entirely. Unless something is done in the way of storing the surplus water the people of the Lower Pecos, the Lower Rio Grande, and so on will have to abandon their farms for want of the water to which they have been accustomed.

In 1868 I was instrumental in introducing the silk industry into South Australia, in conjunction with Sir Samuel Davenport and Prof. George Francis and Mr. Atwater, who was then curator at the museum at Adelaide. I think this climate more nearly resembles that portion of Australia than any other climate I have met with. The success there was most pronounced. The industry has grown from that time until it is now of very great importance. The French, the Italians, and the people of other portions of Europe where silk is grown to a great extent, as well as India, send to Australia now for their seed, which is called "grain." That grain is sent from Australian ports to the proper places, the steamers being fitted for the transportation of it as in China and Japan, and the value of one cargo will frequently be as high as £150,000 to £300,000 sterling. These cargoes are made up simply of the eggs of the worm. From the fact that the mulberry tree flourishes here, and that the leaf contains precisely the constituents that are best adapted for the production of the largest amount of silk and the health of the worm, I think the industry will be established here to advantage. Further than that, the peculiarly dry atmosphere we have here, the electrical conditions of the atmosphere, and the season which can be made so long by a succession of hatches, would make the profits of the industry very much larger than I am informed they are in California.

I also wish to add that not only in the valley of this Santa Fé River, but in all portions of this Territory, the northern half of which I know very well, storage reservoirs can be made in natural depressions with very small expense. In the interior of Australia, 500 miles from the coast, I have known of sheep stations, intended to carry only five hundred sheep, which, by diverting the water, carried fifty thousand head of sheep within three years. Away from the rivers the waters should be carried in some way so as to prevent them from going along either through the deep cañons or the arroyos, which are simply ravines. The water should be diverted from them and retained in those natural reservoirs, and that could be done at a slight expense. I think there is no locality adjacent to the mountains where any very large expenditure need be contemplated to put an enormous area of land under cultivation.

STATEMENT OF FRANK SPRINGER.

The CHAIRMAN. You have heard the examination here. Please state your views with regard to irrigation, and your own experience also.

Mr. SPRINGER. I have lived for about sixteen years in the northern part of this Territory. The condition of the part of the Territory that I am best acquainted with is very much such as Mr. Catron described as applying to land on either side of the mountain ranges bordering on the Rio Grande. There are a number of streams flowing to the eastward, none of which are very large, but which flow out at a very rapid rate, but the fall of these streams after leaving the foot-hills is on an average about 40 feet to the mile. In the mountain region it is considerably greater. I should say that the principal of the streams in the locality I speak of is about 12 to 15 feet wide, and during the *winter season* the flow, at an average, from 1½ to 2 feet of water.

The CHAIRMAN. In depth?

Mr. SPRINGER. In depth; the velocity which would be indicated by the fall I have stated. During the early spring, when the snows begin to melt, and from that on to about the 1st of June, the flowage of the water in those streams is very much increased, so that they oftentimes run five or six weeks at a time at a depth which makes it impossible to cross them except on bridges; 3, 4, or 5 feet deep. Sometimes they overflow their banks and fill the whole valley. I have several times seen one of these small streams in Colfax County, where I formerly resided, 200 or 300 feet wide, running for a week or two. That water, for nine months in the year, is lost.

I presume all of the irrigating is done during the months of June, July, and August; very little is done before that. Occasionally the farmers irrigate the land before plowing it, in order to make it plow the easier; but the great bulk of irrigation is done during these months. The first two of those months are those in which the streams are usually lost. Our rainy season, in the latter part of July and August, frequently produces a large flow of water at that time.

The subject of storage has been very much considered in our part of the Territory, and storage will be undertaken to some extent by private enterprise. I can give, if the committee desire it, some facts with regard to some private enterprises in Colfax County, of somewhat considerable dimensions.

The CHAIRMAN. You may proceed.

Mr. SPRINGER. Those I speak of are upon private property—upon the Maxwell grant, which is a large body of land held in private ownership. During the past year there have been two large irrigating systems put in operation. One of them is from a stream called the Vermejo. From that a ditch 20 feet wide at the bottom has been taken out, running about a distance of 20 miles. The smaller laterals, of course, make the mileage considerably more. This water is carried into a series of natural basins which happen to be so favorably situated as to render it practicable to store in them a great quantity of water without artificial means, except to lead the water into them. There are five or six of those lakes. That system of ditches, with the aid of reservoirs, brings under cultivation about 30,000 acres of land. Thirty thousand is now considered as directly belonging to the system, but with the addition of some similar lakes in that vicinity it is expected to very considerably increase it.

Another irrigation system is taken out from the Cimarron River in the same county by a ditch a little larger—24 feet at the bottom. In that they have made one very large reservoir by re-enforcing the bank at the lower end, adding to the natural bank an artificial one of dirt of about 25 feet height. That system will irrigate about 30,000 acres of land. Besides that there are some smaller enterprises. Those are the two principal ones, whose lands are to be put on market. Those lands are sold at about $15 an acre, including a perpetual water right.

The CHAIRMAN. Do they give any time?

Mr. SPRINGER. Yes; the time is usually ten annual payments at 7 per cent. interest. They get one payment down and have all the payments completed in ten years. The title does not pass until the payments are completed.

We estimate the duty of water, based principally on the experience of Colorado, at a very conservative rate, as we think, about 50 acres for each cubic foot per second.

The CHAIRMAN. That is, a miner's inch to the acre?

Mr. SPRINGER. Yes, I believe that amounts to the same thing.

The CHAIRMAN. One-fifth of a cubic foot per second is, I believe, the miner's inch.

Mr. SPRINGER. I believe so. We think that when a particular district has been irrigated for a number of years water will go farther than before. That seems to have been the experience of those who have been irrigating for five or ten years. As to the crop raised there, all of the crops that grow in the northern part of the temperate zone do well there, and some of our farmers have even been raising pretty good corn crops during the last four or five years, getting a good, quick variety of corn. I know one gentleman who raised 71 bushels to the acre last year on 25 acres of corn. Barley has been grown considerably there this year, in addition to the other small grains that have been mentioned. They are also finding that many fruits grow there very well. Some very fine apple orchards can be seen there now. Of course, as in all new countries, fruit always comes last. There is one gentleman who for ten years has been engaged in creating a very large orchard. That, however, is down in the cañon of Red River, about 1,000 feet below the general level of the country. He raises, I think, everything that can be grown in the temperate zone.

The CHAIRMAN. Does the Red River run through this country?

Mr. SPRINGER. Yes; it heads in the valley I have been speaking of, in Colfax County.

The CHAIRMAN. Are they irrigating much on the Red River?

Mr. SPRINGER. No; there is not much, in this Territory, because the water very soon passes into a deep cañon. They irrigate little patches of ground in the cañon.

The CHAIRMAN. When it gets below the cañon it can be taken out?

Mr. SPRINGER. Yes, but that is pretty well out of the Territory.

The CHAIRMAN. Where would that carry you?

Mr. SPRINGER. That would carry us down by Fort Bascom, that is, on Red River. The Red River runs east of Las Vegas and into the Pan Handle of Texas.

The CHAIRMAN. Where does it go then?

Mr. SPRINGER. It runs down through the northern part of Texas and adjoins the Arkansas.

The CHAIRMAN. Does the country down below require irrigation? Are you familiar with that part of the country?

Mr. SPRINGER. I am not very familiar with that part. The country slopes off very rapidly. I suppose the same principles apply there as in the Rio Grande Valley. I might add on the subject immediately in hand that at the headwaters of almost all those streams originating in the mountains there are ancient lake beds which formed the original source of the streams undoubtedly. The streams break through the mountains in narrow cañons. There are many of those places where a dam 100 feet wide would perhaps create a lake of the average diameter of a mile, with a depth of 50 to 100 feet at the lower end and gradually becoming less. Such as that can, I think, be found at the head of all those streams, and very often in the tributaries of the streams. Those are pretty well up in the mountains, where the water is not so hot, and where it is supposed that the evaporation is considerably less, though we have no statistics on that point.

The CHAIRMAN. Would the suitable places for reservoirs in your locality be on public or on private land?

Mr. SPRINGER. In the locality that I have been speaking of, in Colfax County, they would be mostly on private lands. In the counties *on the eastern slope* of the mountain range there are many such places

'blic land.

Mr. CATRON. The majority would be on public land.

Mr. SPRINGER. I think so; I think on that side of the mountain the majority would be.

Mr. CATRON. On this side they would almost all be on public land.

Senator REAGAN. What is the volume of water in the Pecos River? What is the size of the stream that enters Texas?

Mr. SPRINGER. That I can not tell you.

Senator REAGAN. I thought you described irrigated land on the Pecos.

Mr. SPRINGER. No, not on the Pecos, but from streams farther north; though there are gentlemen here from that county who can give you a great deal of information.

Senator REAGAN. What is the volume of the Canadian River where it enters Texas?

Mr. SPRINGER. That I can not tell except from an estimate. That stream is formed from five streams that I think would average 12 to 15 feet in width, and in the winter season, in ordinary times, 1 to 5 feet in depth.

Senator REAGAN. You are not familiar with the Canadian River down near the "Pan Handle?"

Mr. SPRINGER. I am not.

STATEMENT OF CHARLES H. GILDERSLEEVE.

The CHAIRMAN. Have you given some attention to the subject of irrigation?

Mr. GILDERSLEEVE. Yes. For the last two years I have given considerable attention to that subject in New Mexico and the promotion of irrigation enterprises among Eastern capitalists.

The CHAIRMAN. Please state what you know on that subject.

Mr. GILDERSLEEVE. I have lived here about fifteen years. A little over two years ago the legislature of New Mexico passed some laws that were very favorable to the encouragement of investment by capitalists in irrigation, in storage reservoirs, and similar enterprises. With other gentlemen in New Mexico, I organized several irrigation companies and spent considerable of my time East in promoting them and endeavoring to encourage the investment of Eastern capital in those enterprises. I have encountered a good deal of trouble in that matter. I find in the first place that there is much ignorance among Eastern people on the subject of irrigation.

The CHAIRMAN. Is that ignorance confined to the people of the East?

Mr. GILDERSLEEVE. Hardly; but I think there is more ignorance in the East about it than in the West. The only people before whom I have laid enterprises of that kind are Eastern people—those of New York, Boston, Philadelphia, and Hartford. I find they are very ignorant on the subject of irrigation and they have very little knowledge not only of our conditions but of the capability of production of our soil.

The CHAIRMAN. There is no doubt about that. What can you tell us about the soil of New Mexico?

Mr. GILDERSLEEVE. The soil here, when it has a system of irrigation that will insure a good supply of water, each year, will produce from two to three, and sometimes five times, as much as the soil of the East, that depends entirely on rain fall. The distribution of plenty of literature among our Eastern friends *might* educate them on this subject. I

want to make another statement here affecting legislation, which may be influenced by your report regarding New Mexico. Our conditions are somewhat different from those of any other Territory, and probably from those of all the States. Many of the sources of water supply in New Mexico, and particularly large bodies of land lying contiguous to the large rivers that are suitable for irrigation and colonization, are held by private owners in large Spanish and Mexican grants. From my long experience with those owners, I know that they are very favorably disposed to assist in any effort that will look towards the irrigation of their land or of lands contiguous to theirs that are held by the Government.

In one notable case with which I was connected, the owners of the lands which were adjoining the source of water supply and the river bottoms offered to donate one-half of all their land grants, aggregating 500,000 acres, to an irrigation company, as a subsidy to encourage them to build their irrigating canals and storage reservoirs, but owing to some unfortunate legislation of Congress in the anti-alien act, a corporation was precluded from owning over 5,000 acres of land, and as the area which those people intended to grant exceeded 5,000 acres, and amounted, in fact, to several hundred thousand acres, the company was unable to avail itself of that very generous offer. The company could not take a fee to the land, and could not mortgage it to a trust company or bank, because they were corporations. So we were placed in a very embarrassing attitude, and are yet. Unless Congress will make some legislation to enable these owners to put the land in the hands of companies, or to construct storage reservoirs or mortgage the land, we are in a very unfortunate plight.

I wish to say something with reference to some experience I have had in regard to the Santa Fé River. At the instance of some eastern capitalists, I caused a survey to be made of the river for the establishment of storage reservoirs about 1½ miles east, to ascertain the approximate amount of public or Government land that could be irrigated from the Santa Fé River, and by these storage reservoirs. The report of the engineer was that a reservoir could be established near the city at an expense of $250,000 which would store sufficient water to irrigate between 100,000 and 150,000 acres of land lying from 50 to 300 feet below the bottom of the reservoir. The matter was laid before the eastern investors and they were loath to invest their money and rely solely upon their investment for an income from sales of water rights. They seemed to think that in view of the fact that the Government lands which were now being sold at $1.25 would be worth from $5 to $10 an acre, the Government ought in some way to assist them by donations of land. But, as no encouragement to that end can be offered, they have declined to go on with the storage system or reservoir.

The CHAIRMAN. You appear to have been studying the land question. What would the difficulty be in constructing hydraulic works that would irrigate 100,000 acres of land? Nobody could take that land but homestead settlers. What difficulty would there be in your selling the water to them?

Mr. GILDERSLEEVE. There would be none; but the difficulty is to encourage eastern investors to do the work. They say it is a new thing and a little uncertain.

The CHAIRMAN. What does the company want of the land if the Government is willing to give it to those who go on and buy the water?

Mr. GILDERSLEEVE. As an additional incentive to encourage investment.

The CHAIRMAN. When they have the water, that is pretty much all there is of it?

Mr. GILDERSLEEVE. Yes; there is more land than water, and I am frank to say that I have endeavored to persuade those people that an investment in water lands would yield a handsome income.

The CHAIRMAN. I think they will be convinced after a little while. I feel certain that an investment in water is the safest investment, providing you sell it to the homestead settlers outright, giving them time in which to make their payments; not getting all the money on the first making of the contract, and not attempting to levy contributions perpetually on the settlers. In the first place it would be very difficult to get settlers to take hold of it, if there should be a perpetual tax on them to pay it. They would prefer to own the water-works as a community and take care of them themselves.

Tell us what you have observed with regard to the sources of water supply.

Mr. GILDERSLEEVE. The period of largest water supply in the Santa Fé River is during the months of March, April, and May. The larger part of the water falling during those months, I might say almost the entire quantity, goes to waste. This water, from my examination, by a system of storage reservoirs along the line of the stream immediately north or east of the city of Santa Fé, could all be preserved and then used during the irrigating season of May, June, July, and August, for the irrigation of from 100,000 to 150,000 acres of Government land lying immediately contiguous and to the south and west of the city. I have caused some examination to be made (in connection with organizations with which I am identified) of the Rio Grande River from Espanola to El Paso.

The CHAIRMAN. What distance is that?

Mr. GILDERSLEEVE. About 400 miles. My investigation was prosecuted among the oldest Mexican and American inhabitants living along the line of the river, who were familiar with the volume of water running in the river. They informed me that the months of March, April, and May formed the season of high water in the river. The volume of water at that season is so great that it often threatens to wash out towns and cities lying below Peña Blanca. To my personal knowledge, the cities of Albuquerque, Socorro, San Marcial, and other towns lying on both sides of the river have at various times been threatened with inundations, and have occasioned the inhabitants great apprehension and expense to preserve their towns. They all unite in saying that it would be a great blessing to them if, in that season of the year, the water could be diverted from the main channel of the river and held in storage reservoirs conveniently located on both sides of the river, which should then be utilized during the proper season for irrigation purposes. As far as I know, that is the universal sentiment of the people living along the Rio Grande Valley. I estimate that there are forty thousand people living along that valley that require water for agricultural purposes, stock-raising, and other industrial pursuits, and that ten times as much land lying on both sides of the river could be irrigated by a competent modern system of irrigation from storage reservoirs which could be filled during the season of high water in the river.

The CHAIRMAN. How much would that amount to?

Mr. GILDERSLEEVE. It would amount to about 4,000,000 acres, approximately. Do you wish to know how much of this land would be Government land and how much private land?

The CHAIRMAN. If *you have an idea* give it to us.

Mr. GILDERSLEEVE. I have made an approximation that one-third of the land would be Government land and that would be irrigated along the Rio Grande River.

Mr. WILLIAM L. RYNERSON. If one-third were public land, the balance would be private land. I would like to ask Mr. Gildersleeve to state that a great portion of this land that is called private land consists of community grants or a species of public land.

Mr. GILDERSLEEVE. Yes; I will state that the greater portion of the other two-thirds is covered by either private or community lands or grants to the Atlantic and Pacific Railroad by the Government.

STATEMENT OF WILLIAM B. SLOAN.

The CHAIRMAN. Have you given any attention to the amount of land under cultivation in this Territory by irrigation?

Mr. SLOAN. I have.

The CHAIRMAN. How did you obtain that information?

Mr. SLOAN. As superintendent of the semi-decennial census of 1885, and by personal observation traveling through the Territory.

The CHAIRMAN. Please state how much it is.

Mr. SLOAN. The amount of the lands under cultivation in 1880 was 5,053 farms, with an acreage of 237,392 acres which was improved. The valuation was $5,514,399. The farming implements at that time were valued at $255,162. The live stock at that time was worth $5,010,800. The value of all farming productions at that time was $1,897,771. In 1885 there were 10,511 farms, a gain of 5,458, with a value of farming implements amounting to $1,595,370. The value of the farm products was $2,914,984, an increase of $1,016,910. That was on the farm products alone. If you want the acreage of the Territory, I can give you that.

The CHAIRMAN. Give us the acreage that is under cultivation by irrigation.

Mr. SLOAN. The total land acreage of the Territory is 78,374,400 and the area for pasturage is 63,374,400 acres. Unoccupied pasturage amounted to 12,874,000. Public lands, subject to irrigation, amounted to 13,965,000 acres.

The CHAIRMAN. That could be irrigated?

Mr. SLOAN. That could be irrigated.

The CHAIRMAN. Of private land that can be irrigated, how much is that?

Mr. SLOAN. I do not separate them.

The CHAIRMAN. Would there be as much public land as private land?

Mr. SLOAN. No, there is more public land in the Territory than private lands.

The CHAIRMAN. That is, more of public land that can be irrigated than private land that can be irrigated?

Mr. SLOAN. Yes. The Gila, the Palomas, the Rio Grande, the Pecos, the Red River, and their tributaries, all have their natural flow to the south, the southeast, and southwest. Their valleys, etc., all embrace a large area of public land. Immediately adjacent to the mountains there is quite a quantity of land, what we term bench land, that is subject to cultivation without irrigation. Passing from that—the foothills—down into the valleys below, that are susceptible of irrigation, there are large *bodies of public land* to be found throughout the territory. In Taos

County there are some very fine lands on streams that are tributary to the Rio Grande, that by the construction of proper reservoirs could be made to hold water to be let into the Rio Grande at the proper time. The flood of the Rio Grande is so great that if the water was held at the proper time it could be carried a long way off. The Pecos River, likewise, holds a good quantity of water. Altogether, we have thirty-one streams in the Territory that at proper seasons of the year contain more or less water. The main streams are those larger ones I have mentioned, while the others are tributaries; but in the spring season, after the snows begin to melt, there are large bodies of water, all of which could be husbanded and saved for the purpose of irrigation in the vicinity of those lands I have mentioned.

STATEMENT OF WILLIAM G. RITCH.

The CHAIRMAN. What is your occupation?

Mr. RITCH. I have been secretary of the Territory during the last twelve years, and during that time I acted as governor for about two years and a half.

The CHAIRMAN. You have heard the examination here. Please state to the committee anything additional which may be of interest to us regarding irrigation in this territory.

Mr. RITCH. I have heard something of the examination this afternoon, but I was not here this morning.

The CHAIRMAN. We shall be glad to have any statement you desire to make.

Mr. RITCH. My statement would be more general than specific perhaps. I will say that my means of information have been more especially in connection with the Bureau of Immigration, with which I was associated in various capacities for seven or eight years.

As to the sources of water supply, they are mainly in the central and northern portions of the Territory from the mountains, and depend very greatly upon the quantity of snow that falls in the winter. Of course, we have the rainy seasons, but the water usually runs off rapidly, and we have the benefit of only a small proportion, relatively, of the quantity that falls. It is very manifest to me that in order to have the full benefit of the precipitation, storage reservoirs are an absolute necessity. The present system of irrigation is manifestly a very wasteful one. With a proper saving of the water, I have no doubt but what anywhere from fifteen to twenty times (probably more) land could be brought into use than is now under cultivation. If the water was stored and taken out in pipes the increased quantity of land that could be brought under cultivation would be almost indefinite; I should say, possibly, an increase of forty or fifty times; that is, saving all the water and utilizing it to the best possible extent. The soakage of the water is very great at the best when it is taken out in open ditches. Our soil, I think, is unexceptionable.

The CHAIRMAN. Are the crops good?

Mr. RITCH. The crops are good wherever you can get water on the land.

The CHAIRMAN. You have been looking at this question with a view of bringing emigrants upon the land. Suppose the country were accurately surveyed, and the places for reservoirs located, showing that the land could be covered by certain water designated, and if the expense

of the work were estimated by the Government engineers, would you then be able to get colonists to take up some of the land?

Mr. RITCH. Certainly; and I think there would be no trouble in that direction. Enterprises of that kind have gone on before in other places, and I think we shall have no trouble in having them taken up here in New Mexico.

I reside in the southern portion of the Jornado del Muerto, and I am quite familiar with that portion of the country. In Socorro County, and counties adjoining that, I think more than one-half the land is Government land, which is good soil, and can be reached through reservoirs where the water has been brought from the Rio Grande. Of course surface water could be utilized. There are cañons in the mountains where natural reservoirs could be made. There are also depressions in the Jornado, where large quantities of water could be stored at little expense.

In regard to the fruits that can be produced in this Territory, I think it is one of the finest fruit-growing countries in the United States. As to the fruits produced here at Santa Fé and in the Rio Grande Valley, you find no better. There has been sufficient experiment in that direction by amateurs.

The CHAIRMAN. Do you get a crop nearly every year?

RITCH. Nearly every year. I think we are a little peculiar in that respect. We seldom have a frost; and while the crop may be a failure in one locality, it is generally very good; certainly away above a half or three-quarters of the crop of what may be termed a good year. Our soil is susceptible of growing all the crops adapted to the temperate zone.

The CHAIRMAN. How do the crops here, in quantity and quality, compare with the crops raised where people rely on rainfall?

Mr. RITCH. I think where we have a certainty of irrigation we can produce crops in very much greater quantity. There is one advantage in connection with irrigation—that we need little or no fertilizers, because, coming down with the water, in solution, are natural fertilizers, and no artificial fertilizers are required.

The CHAIRMAN. Has there been an experiment here of cultivating the land for a long time?

Mr. RITCH. Yes; for two hundred years or more.

The CHAIRMAN. Does that land produce as good crops as it ever did?

Mr. RITCH. That is its general reputation. It is understood that it rather improves in the valleys.

The CHAIRMAN. Do the Mexicans manure their land—put fertilizers on it?

Mr. RITCH. I do not understand that they do. There may be exceptional cases, but I know of none. They depend on irrigation to fertilize the soil as well as to moisten it.

STATEMENT OF HENRY F. GRIERSON.

The CHAIRMAN. What is your occupation?

Mr. GRIERSON. I am foreign immigration agent of the Santa Fé Railroad.

The CHAIRMAN. Please give us such information as you may have in regard to irrigation in this Territory.

Mr. GRIERSON. The information I can give is largely the result of *what I hear from* people that we bring in here. The universal opin-

ion of the farmers that have come from foreign countries where they have had to depend upon rainfull is, that they would not, under any consideration, go back to the old method of depending upon that source for watering their crops. They find that irrigation is much more satsatisfactory, as they can give the crops what water they require and at the right time, just so much and no more. The crops raised under irrigation are very much heavier than the crop raised under rainfall. For instance as to alfalfa; in Kansas they would consider themselves very lucky if they got 2 tons to the acre each year, where they depend upon rainfall; here 5 or 6 tons is a very conservative estimate of the crop. The trouble we have had so far is not in getting people to come here, but in getting suitable locations for them. Wherever we can find land with good water facilities, at reasonable prices, we have no difficulty at all in colonizing it.

Take the Maxwell grant, for instance, of which Mr. Springer spoke a few minutes ago. It was only quite lately—a few months ago—that they put that land on the market. They sell it on long time payments, with light interest. Forty thousand acres that they have under ditch will, I think, be sold by next year to small farmers and be brought under actual cultivation. On the 15th of last April I was there, and there was not a spear of any product then growing, except the natural grass. I went there two weeks ago again, and one farmer, on 1,200 acres, had as good a crop as any 1,200-acre farm in the world, comprising alfalfa, oats, barley, and vegetables, beside other crops, and hundreds of fruit-trees thriving. It may interest you to know that that land was previously worth probably $2 or $2.50 an acre for grazing cottle and would not now be worth that because of the present low rates for cattle. They have increased that land in value from $3 to $12 or $15 an acre.

When the Australian commission was here a few years ago, whose report I read in the Government book prepared by Mr. Richard J. Hinton, they said that land out West was plentiful but of little value; that the value here was in the water. That of course is very manifest. I have probably brought in more settlers for the past few years than anybody in the Territory, and they are all satisfied. Last spring several French wine growers came here by my invitation to look into wine possibilities in this field. They have been importing a half a million dollars worth of wine from Louisiana to cross with French wines. They do not like the mixture very well. The California wines they liked less, the amount of alcohol in it not being sufficient to make it a good carrying wine. They say it is their intention, if the Government or any other corporation would put any large body of land under cultivation, to bring a large number of men here for the growth of grapes and the making of wine for exportation to France.

People from France have also been looking at this Territory with a view of observing how it would suit for silk culture. The conditions of electricity and other features which they do not understand make this one of the best places for silk culture in the world. Some French gentlemen are to be here in a few days who will determine its possibility as to that.

They tell me that they have tested the grapes grown, and analyzed the wine made in the Rio Grande Valley, and find that the percentage of sugar is large. The soil here has a constituent such as it has near Naples—a mixture of volcanic ash, which seems to have the effect of enriching the grape very much.

As to the question of soil being impoverished by constant cultivation

without fertilization, there is no doubt whatever that irrigation fertilizes land very considerably, on the Rio Grande Valley at least; I can not answer for other places. In the Rio Grande Valley you can take what seems to be dead white sand, irrigate it for a year or two, and it will grow beautiful crops. Every year it is observed that the growth of the plant is aided by the addition of alluvial deposits from the water, as is the case in Egypt, South Africa, and India.

The CHAIRMAN. Have you been through India?

Mr. GRIERSON. Part of India. I know South Africa quite well so far as irrigation there is concerned.

The CHAIRMAN. How does India compare with this country as to irrigation?

Mr. GRIERSON. This is a very rich country, very much like South Africa. They do there very much as we do—raise two crops a year. In the winter they irrigate their growing wheat.

The CHAIRMAN. If this is a richer country than India, how do you account for their supporting 250,000,000 of people on 800,000 acres of land?

Mr. GRIERSON. It is accounted for by intense cultivation and the fact that they can live on very little—a little rice makes a very good meal for the Hindoo. They do not want fine foods or woolen clothes.

The CHAIRMAN. We have over 1,300,000 square miles of arid lands.

Mr. GRIERSON. Irrigated land will without doubt support a very much larger population in any portion of the world than land which depends upon rain-fall.

There is another point which these French people feel confident of, that is, that in New Mexico there is a very superior capability for raisin growing—a capability such as no country in the world has. The percentage of moisture or humidity in the southern portion is about 29 per cent. by weight, which is very low. You can dry your grapes in your own vineyard. In California and other places they have to ship their grapes away from their vineyards in order to dry them, and then they have to bring them back.

The CHAIRMAN. Similar conditions of climate exist in Arizona, do they not?

Mr. GRIERSON. Perhaps so, though I can hardly state that to be a fact of my own knowledge. It may interest you also to know that a French commissioner was here in the spring for another purpose. He had been looking all over the world for a sanitarium for French consumptives. He was the agent of a society of rich people. They have been examining all parts of the world, and they report that New Mexico is about the best place in the world for the cure of consumption. The Mexican Government have offered them a donation of 10,000 acres of Government land. The gentlemen who have examined both countries say that New Mexico is their choice.

STATEMENT OF E. S. STOVER, OF ALBUQUERQUE.

The CHAIRMAN. How long have you resided in New Mexico?

Mr. STOVER. Thirteen years.

The CHAIRMAN. You have heard what has been stated here. If you can add anything that will be of service to the committee, we will be glad to hear it.

Mr. STOVER. I should like to re-enforce what has been said by Judge Bristol, that it is not a question of land but of water. As has been *stated, in Bernalillo* County, at Albuquerque and the town of Berna-

lillo, 20 miles this side, it is a very rare thing for us not to have water for the land we are cultivating. I suppose that not over 15 to 20 per cent. of the river bottom is cultivated. At the present time I think we have nearly all the water that is required for the land that is being cultivated. There apparently lies also under Albuquerque a large basin of water. For instance, while we have had no rains this year so far, except a very few little showers, at any point on my place within 2 miles of Albuquerque I can strike standing water at 2½ feet. In fact, I have a fish-pond on my place which was got by simply taking a plow and scraper and scraping it out. There is nothing, in fact, but water from below—subirrigation.

I desire to say also that in the Rio Grande Valley we raise good crops by subirrigation; that is, forage crops, not good crops for corn or wheat or even grapes, but forage crops. There lie on each side of the river what are called mesa lands. I should say that in the counties of Bernalillo, Valencia, and Socorro, nearly a million of acres on each side of the river is not irrigated at all, although it is most excellent land if they had the water with which to irrigate with. It can not be irrigated with the systems we have now. With other gentlemen I had a survey made on the east side of the river several years ago by a competent engineer, and his report was that he did not think it was practical to come up the river far enough this way for private capital to take out a ditch from the Rio Grande to irrigate this large mesa or tableland which lies east of Albuquerque, but recommended the reservoir systems. Of course, he said it could be done, but the expenditure would be so large that no private capitalist could be induced to take hold of it. I understand that is largely so on the west side of the river also. If the report of the engineer would be of any use to you I will furnish you a copy of it.

The CHAIRMAN. We should like to have the copy.

Mr. STOVER. I will furnish it. It will give many figures in regard to the matter.* My opinion is that if irrigating or diverting the water from the main stream diminishes the amount of water in the stream, by the time we irrigate what lands we have in Bernalillo County our friends down below in Socorro County will not have any water at all. Having taking some interest in that matter and inquired into it, my opinion would be that the way to solve this matter would be to keep this vast amount of water above us in the Rio Grande Valley.

The CHAIRMAN. You think a system of reservoirs would answer the purpose?

Mr. STOVER. From my experience and from the information I have had from competent engineers, I am convinced that this system of holding the waters back in the mountains is the proper system.

STATEMENT OF ALBERT J. FOUNTAIN, OF LAS CRUCES.

The CHAIRMAN. How long have you resided in Las Cruces?

Mr. FOUNTAIN, I have resided in the Mesilla Valley for twenty-seven years.

The CHAIRMAN. Tell us what you know of irrigation here?

Mr. FOUNTAIN. I have for some years made a study of this subject. I foresaw years ago that we would experience the difficulty we now encounter. I speak specially now of what is known as the Mesilla Valley and the great table or mesa land adjoining it. In the Mesilla Valley we

* Report was not received

have in the river bottom about 130,000 acres of land, of alluvial deposit, through which the Rio Grande meanders. About 30 per cent. of this land is under cultivation, producing the finest of all kinds of crops—wheat, corn, on the same land each year by irrigation only. The floods come down in the spring, spreading out to places in our valley for a mile and a half in width, running probably six weeks to two months, and during that time a sufficient body of water flows by us, going west, to the ocean, to irrigate millions of acres of land lying on the table lands or mesa on each side of us, all of it being Government land, very little of it at this time being appropriated. Above us on the valley of the Rio Grande are a number of deep cañons and streams, such as the Perches, the Animas, the Palamas, the Cuchillo Negra. They drain the Rocky Mountain range. When those streams come down they add to the flood which comes from the northern part of the Territory.

These great cañons afford probably the best opportunity of a reservoir system, with little expense, that can be found anywhere—especially the Perches, through which a great quantity of water flows down during the year. There are the best of facilities in the Perches cañon for holding water, below Hillsboro, and so of all the other streams I have mentioned. If a storage system could be established by which this water might be saved it could be taken out on this mesa land, especially on the Jornada del Muerto on the east of the river, a tract of about 90 miles in length, averaging about 30 miles in width. I am very familiar with that section. A very large portion of that country could be reclaimed. There are great facilities for storage of water on the Jornada del Muerto. At times great streams rush across it. I remember on one occasion I was water-bound for several hours by a torrent of water probably 6 or 8 feet in depth, and several feet in width, rushing across the Jornada del Muerto. I was stationed there while in the military service in 1863 and 1864 at Fort McCrea, and I made a note at that time of the water fall and kept a note also of the amount of the water that passed from the Jornada del Muerto through the Fort McCrea cañon. On the west bank of the Rio Grande, that is, on the mesa lands, say from Deming south, and the country between Deming and the Rio Grande, is a vast tract of very level country, unappropriated, which could be brought under cultivation if water could be put upon it. I believe that could be done by storage of water in the north.

It is my opinion, derived from actual observation, and from a study of the question, as well as from inquiry of engineers and those who profess to be familiar with the subject, that from 8,000,000 to 10,000,000 acres of Government land now unappropriated, could be put under irrigation and reclaimed if we could save by storage this water which runs off to waste every year. The engineers tell me they will experience no very great engineering difficulties in doing that. There is no doubt that lands on the mesa, if put under irrigation, could be made quite as valuable as those on the river bottom. An acre of unimproved land in the Mesilla Valley is worth now from $25 to $30, with water facilities. If they could put in alfalfa it would produce from $50 to $60 per year. Alfalfa is an unfailing crop, with water. Or if put in vines the acre of land will produce $250 per year. The vines are an unfailing crop. If put in fruits it will bring something less than that, or about that. The apple crop seldom fails. The peach crop frequently fails, however.

I have experimented largely and for many years with small fruits and *vegetables. I have* laid out a small piece of land 40 feet square, and

divided it up into pieces and experimented with it. I find that with full irrigation a double crop can be produced compared with the crop that can be produced with insufficient irrigation. Without irrigation nothing can be produced. In addition to what has been stated by other gentlemen from this section, we can grow rice and tobacco. Experimentation with cotton has shown that it can be produced not only on the river bottoms but on the mesa. Adjacent to the valley of the Mesilla, about 15 miles to the east, is a range of mountains known as the Organ Mountains, cut up into cañons. Torrents of water flow from the mountain to the river in the rainy season. Sometimes they flow down through our town, threatening instant destruction. We have been compelled to erect a dam in order to protect our town. There are the best of facilities for preserving that water. A storage system there would, in my opinion, furnish water enough to fill a large canal which would supply the necessities of the valley below it, and El Paso, for several months in the year—not sufficient for the whole year, but as a feeder it would aid considerably in keeping up the water supply of El Paso.

On the subject of fertilization, lands are enriched by irrigation. Lands entirely barren—sand-bars on which nothing would grow—will, if irrigated one year, produce good crops; if irrigated a second and third year the land becomes as good as any land that we have in the valley. At a certain period of the year, when what is known as the Puerco River comes down to our place, a large amount of sedimentary matter is contained in suspension in the water, probably 10 per cent. of it; but that is not for any great period, probably four or five weeks during the year. That enriches our land to such an extent that irrigation with that water from the Puerco River would in itself be more valuable than all the fertilization that would be put upon it excepting with irrigation. It is my opinion, derived from a study of the subject, that if the water be held in reservoirs placed upon those high lands there could be opened to settlement of the public lands in the county of Doña Aña at least 5,000,000 or 6,000,000 acres. On the eastern side of this Organ range there is a broad valley 50 miles in width and 150 miles in length, bounded on the east by the Sacramento Mountains and the White Mountains. At certain periods of the year there flow from those mountains into this valley great quantities of water which evaporate and waste. In that valley many hundreds of thousands of acres of land now unappropriated, valueless for any purpose, even for grazing purposes (for there is no water), could be reclaimed and opened for settlement. The same thing may be said of the adjoining county of Lincoln. The White and Sacramento mountains are in that county and partly in the county of Doña Aña.

To the east of the Sacramento Mountains flows the Pecos River. Artificial irrigation is now being carried on there. Canals are being taken out and large reservoirs are being constructed. But between the Pecos River and the White and Sacramento mountains—a strip of country nearly 60 miles in width—vast quantities of land now unappropriated could be reclaimed by artificial irrigation and by the storage of water.

The CHAIRMAN. Then you attach much importance to Government surveys for ascertaining the possibilities of storage, etc.?

Mr. FOUNTAIN. I attach the utmost importance to them. It is my opinion, based upon the experience of the last four or five years, that if the Government does not take some such steps the dry belt will [illegible] extending to the *north, and will* in time dry up the Mesilla Val[illegible]

where we have millions of dollars invested in the finest fruit lands in the world. We have made magnificent orchards and vineyards. This year we might have lost them.

The Rio Grande is now absolutely dry, and we lose a fine crop of alfalfa. If it be true that the diversion of water north of us is the cause of the drought, then it will continue; if it be true that the drought is the cause of the light rain-fall of the last few years, then we may hope next year to have an increase of rain-fall and sufficient water for our necessities.

But we are brought face to face with the fact that vast quantities of water are being taken out north of us, as has been said by Governor Stover. Great canal systems are being inaugurated. If that water be diverted from us, as it probably will be, and if the Government affords no remedy by giving us a system of storage supply, we will be ruined.

But, independent of that, we desire, of course, to populate our county. We desire to colonize it. We desire that these vast tracts of land, at present comparatively valueless, should be opened to settlement. I believe that will be done if the Government will establish a system of water storage. Therefore I attribute to the movement on the part of the Government in the matter of surveys for irrigation of the utmost importance, and I think that expresses the view of every citizen of this Territory. Not only will it be of very great advantage to us, but it will tend to settle what may be an international complication. Our people are diverting water to which the people of our neighboring State of Chihuahua, in Mexico, claim to have a vested right.

The CHAIRMAN. We went into that fully yesterday in El Paso.

Mr. FOUNTAIN. A portion of the county of El Paso has been dried up. This storage system will entirely eradicate that evil and will afford relief. I might say much more, but so many gentlemen have gone into the subject fully that I have no need of saying anything further.

FURTHER STATEMENT OF T. B. CATRON.

Mr. CATRON. There was one statement made here which I think is a little inaccurate. Mr. Sloan made a statement that there were thirty-one rivers in this Territory, the water of which might be stored. I have traveled through this Territory for the last twenty-three years, and I am acquainted with nearly every river in the Territory. I can enumerate over one hundred and fifty rivers that have constant water in them, which can be stored. The sources of nearly every one of those rivers is on the public domain, and the places for the storage of water which I would conceive to be proper places for storage, are cheapest and best, most of them on the public land. Very few of them are on private property.

STATEMENT OF W. L. RYNERSON.

The CHAIRMAN. If you know anything in addition to what has been stated, please give the committee the benefit of it.

Mr. RYNERSON. There is one matter in addition to what has been testified to which might be an advantage to the committee.

I have been in this Territory for twenty-seven years. In addition to the testimony to which I have listened I wish to add something in regard to storage reservoirs in the Rio Grande. I do not believe it is practical. I think no matter how high you may build your dam, that *in a very short time* it will be filled up with sediment, and you will have *no way to clean it out.* When the Rio Grande is high it carries, much

of the time a vast amount of sediment. At certain seasons of the year the water is quite clear.

If reservoirs were constructed out of the bed of the Rio Grande you might run the water into these reservoirs when it is not being used in the valley for irrigating purposes, because there is a certain portion of the year—two or three months—that it is required for irrigation.

For the section of country lying below what is called the Jornade del Muerto, if the water of the Rio Grande was conducted on to that of the Jornada del Muerto, which has been called a desert, and is an extent of country some 75 miles in length and about 25 in width. There are natural depressions all over this Jornada del Muerto that would hold all the water that the Rio Grande would run in a season. That is my opinion. The water then could be conducted from this point down to our Mesilla Valley and also supply Texas, as has been suggested. This is a mere idea of my own.

STATEMENT OF R. N. WHITE, OF SIERRA COUNTY.

The CHAIRMAN. How long have you lived in this Territory?

Mr. WHITE. I have resided in Sierra County, this Territory, about nine years. The Rio Grande runs through it for about 50 miles. The county is almost entirely Government land. I think there is not more than one hundredth part of the county which is not so. There are five rivers running through this county from west to east, having their sources in the Black Range. There are many places which are specially good for damming and preserving the water. There is a range of mountains dividing them, at about one-half their length, and at every place where the rivers break through this range of mountains—the Cuchilla Negra range—dams of not more than from 250 to 500 feet in width would back up waters for a distance of from 1 to 10 miles. Another source of dams could be found south of the Alamosa, the Cuchilla Negra, the Rio Polomas, and the Rio Las Animas, with which to irrigate a strip of country 10 miles in width and 50 miles in length, beside serving as reservoirs for the Mesilla Valley, that valley being a continuation nearly of the valley of the Rio Grande, just running northerly and southerly.

The county of Doña Aña raises all the vegetables and almost all the fruits. The altitude is about from 3,800 feet to 6,000 feet. There has been a dam on one of those streams, built by private parties, which illustrated the feasibility of penning the waters. That dam was on the Rio Perches, and dammed up the water for about a mile in length for the entire length of the valley. It was neglected and washed away. The sediment is not a drawback at all. It has not been so found there.

I am acquainted with other parts of the Territory and can confirm the statements that have been made by the other gentlemen here.

Mr. CATRON. What proportion of your county could be reclaimed or cultivated if there was water stored there in your various streams—of the total amount of acres in the valley, what percentage?

Mr. WHITE. Fifty per cent. The Jornado del Muerto is part of the county. Of the Rio Grande Valley there are more than 600 square miles which can be irrigated.

The CHAIRMAN. More than 50 per cent. of the whole can be reclaimed?

Mr. WHITE. Yes; I think so.

Mr. STOVER. I think *that is true* all over the Territory.

STATEMENT OF M. S. OTERO, OF BERNALILLO COUNTY.

The CHAIRMAN. The committee will be glad to hear any statement you wish to make in regard to farming in this country.

Mr. OTERO. I am a very poor farmer, but have observed a little about the great lack of water in the country and the disadvantage at which the people are placed on account of it. I think that if the Government would help us a little we could in our county alone have enough farming land for double the number of people that are in the county, and it is one of the largest counties on either side of the river. I think that by building a dam probably up above Peña Blanca on the Rio Grande, the water could be taken up on the mesa east of Albuquerque, which is a stretch of land about 25 miles in length and 12 in width, very good land. There is enough water in the Rio Grande to store reservoirs on the mesa or prairie, if the water could be raised. The whole of it could then be reclaimed.

Then you come to the Jaemos range, or the Tejaemos, as it is called in the survey. That section of country has some streams. We have some beautiful streams there at the tops of the mountains. There are five or six places that, with very little cost, would enable us to have an immense storage of water by piping that water or fluming it on top of the mesa. Between the Puerco and the Rio Grande there is another mesa of about 15 to 20 miles wide, and probably 25 miles long, or 30, as far as Albuquerque. It runs clear on through to the Rio Puerco as far as 50 miles probably. I am satisfied that if that river could be brought up on top of the mesa we would have 300,000 or 400,000 acres of land that could be irrigated and made to produce. To-day it is going to waste, and the same thing can be said of the Rio Puerco range.

On the Rio Puerco there is an abundance of good, tillable land, but we have not the means to store the water. There are three or four months of the year that big volumes of water run down without any way of saving it. The crops this year on the Rio Puerco have been very good. The corn is as good as you can raise anywhere in the country, but the wheat was a failure on account of the lack of water. The people could not save the water or take it out of the Rio Puerco; it came in such volumes as to carry away the little dams, and they lost their wheat crop. The corn crop was very good. On the west side of these same mountains, and on the the range of the San Juan mountains, the same thing could be said. There is an immense territory there, of which, with proper reservoirs, all the land could be saved.

The CHAIRMAN. Then you think an engineer's survey and estimate of cost would be valuable?

Mr. OTERO. They would indeed. We do not suffer in our county for the want of water, but with more water we could make that county a big country—a very paradise.

Mr. RYNERSON. If these storage reservoirs were made and the water was conducted on the land you spoke of, would it not injure your sheep ranges?

Mr. OTERO. No; I do not think it would. We do not range our sheep there. We would like to have that land on the west of the river very much.

The CHAIRMAN. You can go farther back with your sheep when you *get the water?*

Mr. OTERO. Yes.

Mr. CATRON. There are some things more valuable than sheep ranges.

Mr. STOVER. Are you familiar with northwestern New Mexico?

Mr. OTERO. Not very much. There is a beautiful spot at El Rato. There is much level and beautiful country there if water could be got on it. I do not think that a reservoir would be very costly. I am more interested in the Tejaemos Mountains, and I think Major Powell will agree with me that it is a great country. That country would irrigate the western part of our county, which will make a Territory of itself.

STATEMENT OF L. S. TRIMBLE, OF ALBUQUERQUE.

The CHAIRMAN. How long have you resided in Bernalillo County?

Mr. TRIMBLE. I have lived there about ten years. We have plenty of water, but it comes at the wrong time and gets away from us so that it does not be of any use. If you can invent any means of keeping that water here until we want it, you will have acomplished a great thing. There is enough water to-day flowing out of the Sandia Mountain, 12 miles east of Albuquerque, and that has flowed out of it in the last three months, to irrigate the mesa land east of Albuquerque from Bernalillo to Indian village, a distance of about 38 miles. There was last week a stream of water running out of that cañon with a rush which has become as fine a stream as you would care to look at. When there are rains, there is a perfect torrent rushing out of these cañons.

The CHAIRMAN. Is it not a fact that that is the condition of most of the cañons in the Territory—that there is a rush at the time of high water, and that what you want to do is to keep that water back by dams or by storing it. You first want a survey to show what can be done?

Mr. TRIMBLE. Yes; this water can be kept back out of the mesa in the winter.

The CHAIRMAN. That can be determined by surveyage, if you have the water and the land; the survey is desirable to find out in detail what you can do?

Mr. TRIMBLE. The water is here if it can be utilized.

The CHAIRMAN. And the land is here?

Mr. TRIMBLE. The land is here. If the land that is on the level could be utilized, the crops of New Mexico would be increased sixfold.

Mr. CATRON. Six hundred fold.

Mr. TRIMBLE. The crops of Bernalillo County could be very greatly increased if that single mesa were utilized. There is no question in my mind that if the water could be preserved it would be a great benefit to the country, and it would induce people to take up the land.

STATEMENT OF JAS. K. LIVINGSTONE, OF LAS CRUCES.

The CHAIRMAN. What is your business?

Mr. LIVINGSTONE. I am general agent for the real estate—the lands of the Atchison, Topeka and Santa Fé Railroad in New Mexico.

The CHAIRMAN. Can you add anything in the way of information to what has been said here?

Mr. LIVINGSTONE. I have lived in the Territory for about eight years. I have frequently heard the criticism made that if all the land were brought under cultivation *which it is* claimed can be irrigated in New

Mexico there would be no market for its produce—that we are too isolated from the other States and Territories, and that being on the Mexican border we would be unable to find a market for our produce. The fact is we have a fine home market. I believe that is a point that has not been touched upon to-day.

Adjourned.

ON THE TRAIN AT LAS CRUCES, N. MEX.,
September 8, 1889.

The committee met pursuant to call of the chairman.

Present, Senators Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF JOHN B. BOWMAN, LL. D.

The CHAIRMAN. How long have you lived in New Mexico?

Mr. BOWMAN. About seven years; five years of that time at Aleman on the Jornado del Muerto, and here at Las Cruces.

The CHAIRMAN. Are you familiar with the Rio Grande Valley in New Mexico?

Mr. BOWMAN. I am familiar with the central and southern portions, extending from Albuquerque down to the State line of Texas. The entire extent of that valley through New Mexico is about 360 miles. From Albuquerque to the State line it is about 230 miles. A section of that portion in southern New Mexico is known as the Mesilla Valley, and is about 50 miles long, Las Cruces being the chief town. Another section lying north of that is known as the Jornado del Muerto, rising from the river at the town of San Marcial, and widening out into a broad, beautiful valley of a higher level, nearly 100 miles long, and an average width of nearly 40 miles. Another section extends from San Marcial to Albuquerque, the first level being from 3 to 5 miles in width, and extending indefinitely up on to the mesa.

The CHAIRMAN. What are the sources of the water supply of the Rio Grande Valley, and what the annual amount of water for irrigation purposes?

Mr. BOWMAN. The sources of water supply are the Rio Grande, rising in the Rocky Mountains of Colorado, and from tributaries which below Albuquerque flow almost exclusively into it from the west side, and also from the storm-waters which fall generally in the months of July, August, and September, the average annual rain-fall being from 10 to to 12 inches in the valley.

As to the amount of the annual supply of the Rio Grande and its tributaries for irrigation purposes, I have no means of estimating, but if properly saved by dams and by a system of storage reservoirs and canals, I am satisfied that, in connection with the storm-waters gathered from the mountains, the supply would be ample for all the irrigable lands in the valley. As it is, this river rises to flood height usually in the months of May and June, from the melting of the snows in the Rocky Mountains; flows rapidly to the Gulf, oftentimes with great damage and destruction; then subsides quickly, as in the last two years, drying up bodily for hundreds of miles and for several months below Albuquerque, leaving the crops to perish and the farmers to lose hundreds of thousands of dollars, and stopping all immigration into the *valley. This natural* flow of the water to southern New Mexico and

western Texas and to Old Mexico is being rapidly curtailed by the large immigration into southern Colorado and the northern part of New Mexico. These thrifty people are constructing canals right and left, and by degrees are taking the Rio Grande out, during the farming season, almost bodily. The result is, that this season a water famine has existed in the valley for hundreds of miles above and below El Paso, and a panic exists among the people as to the future supply. This in my judgment can only be remedied by the saving of the flood-waters of the river in the early season, and of the storm-waters from the mountains later on, by a system of dams, reservoirs, canals, and laterals, to be constructed either by the Government itself or by its encouragement of private capital. Unless this is speedily done, one of the fairest and most productive portions of the southwest will be desolated and deserted. Immigration to it has already ceased, lands have greatly decreased in value, and many people are preparing to leave this valley.

The CHAIRMAN. What is the character, extent, and source of water supply of the large area of country known as the Jornado del Muerto, upon which you have resided for five years.

Mr. BOWMAN. It is one of the most interesting and peculiar conformations of lands in all the arid regions. It is a broad, fertile plateau, at an altitude of 4,500 feet above sea-level, on the thirty-third parallel of latitude, lying somewhat in the form of an ellipse rising gradually from the eastern side of the Rio Grande near San Marcial several hundred feet, and then sloping downward and southward for about 100 miles, with an average width of 40 miles, bounded on the west by the Cristobal and Caballo Mountains, curving around with the river behind them to Rincon, a station on the Atchison, Topeka and Sante Fé Railroad, which crosses this valley in a direct line, and on the east by the San Andreas Mountains then narrowing down to the base of the Doña Aña and Organ Mountains to a beautiful mesa, nearly to El Paso, crossing the State line of Texas about 20 miles above said city. This remarkable area of country, containing about 2,000,000 acres, has not a living stream of water upon it, except one or two small springs in the Caballo Mountains. On the eastern side of the railroad, for 100 miles by 25 miles in width, there has not been, in all the past nor at present, but two habitations outside of the railroad stations, one of these the "Aleman" or "Martin's well," and the other Ojo Denaio, a small spring which rises and runs a few hundred yards and sinks on the plains. The railroad supplies its stations with water hauled from the Rio Grande and from reservoirs and wells sunk at great depth. This area of country is capable of 50,000 homes for colonists, if water could be put upon it.

The climate is perfect both winter and summer. Its soil is rich and highly productive, having been formed by the deposits from the adjacent mountain ranges for ages past, and is admirably adapted to the growth of all kinds of fruits and cereals of a semi-tropical climate. The whole plain and mountain sides are covered with luxuriant growth of grama and other grasses indigenous to these arid regions, and indications are most favorable for large mineral deposits in the surrounding mountains, which are also covered by an abundance of timber for fuel and other purposes.

The CHAIRMAN. You speak of the Mesilla Valley; what is its extent, and what its resources?

Mr. BOWMAN. The Mesilla Valley extends from a point near Fort Selden to the Texas line, *a distance of* about 40 miles. The lower level

of land is from 3 to 5 miles in width, the mesa lands on the east about 15 miles in width, extending to the Organ Mountains, and on the west side extending indefinitely towards the town of Deming, on the Southern Pacific and Atchison, Topeka and Santa Fé railroads. The lower level of land has been partially under cultivation for several hundred years, and has a wonderfully rich soil, capable of the production by irrigation, from the muddy waters of the Rio Grande, of all crops of cereals, and especially of all semi-tropical fruits and vegetables, to a remarkable degree. Perhaps no country in America can excel it in the production of all varieties of grapes, both as to quantity and flavor. Apples, pears, peaches, plums, apricots, figs, and nectarines grow to great perfection, superior, we think, to California.

The CHAIRMAN. You speak of the Rio Grande failing in its supply and having been absolutely dry for several months during the past two years. How can these valleys be relieved from this water famine in the future, and how can this large area of mesa land be settled up?

Mr. BOWMAN. Only by saving the great floods of waters of the Rio Grande which waste away to the Gulf of Mexico every year, during its spring rise, and also gathering the storm waters which flow from the mountains in the summer and fall.

The CHAIRMAN. Have any steps been taken by the people themselves to protect them from this threatened annual water famine? You have organized a company, I believe. Please state its character.

Mr. BOWMAN. More than a year ago a number of the best citizens of southern New Mexico and El Paso, Tex., many of them small farmers, whose all depended on a regular water supply, fearing the increased failure of the river from its absorption by the people of Colorado, and with a view to settling up the large tracts of adjacent mesa lands, organized a company, known as the Jornada and El Paso Canal and Reservoir Company, subscribed a fund for preliminary surveys and expenses, and appealed to Congress for aid in the construction of a canal and laterals, with a series of storage-reservoirs, to be built under the direction and auspices of the Government, by private capital, and in exact line with the policy indicated by this investigation.

The organizer ask the right to operate under a national charter under the direction of the Secretary of the Interior, and for the right of way, and to take from the Rio Grande, under proper restrictions by the Government, the waste or flood waters of that river; also, to gather the storm waters from the mountains and plains, and to conduct and store the same by a system of canals and reservoirs, to be located by the U. S. Geological Survey, taking the waters from the river at any point on either side of said river, between Fort Selden and Albuquerque, and carrying them across the Jornada down at the base of the Organ Mountains, with a branch canal or lateral near Fort Selden running south through the Mesilla Valley to the State line of Texas, where the waters can be conducted into the large international reservoir, which is suggested to be built by the Governments of the United States and Mexico. In order to construct this large and expensive system of works, and to develop the large area of public lands on this peculiarly situated Jornada del Muerto, and to save the beautiful Mesilla Valley from a constantly recurring water famine, they ask for an appropriation of $25,000, to be expended under the direction of the Geological Survey, for the permanent surveys and locations of said system of works, and they ask also for the right to purchase at a reasonable rate the alternate sections of public lands along or near said canals and reservoirs, *to an amount* not exceeding 1,000,000 acres, which lands are

now practically worthless and uninhabited. Only in this way can private capital be induced to take hold of this great work, which will cost several millions of dollars. This settlement of more than 2,000,000 acres of rich but arid lands will be postponed indefinitely, unless these works are constructed by this means or by the Government itself.

The policy of the people who have organized this company is not only to save their own valley, but to encourage the settlement of these unoccupied lands by colonies of small farmers, who will be enabled, under governmental protection, to secure water rights which will attach perpetually to the lands purchased by them.

I beg leave to file with this statement copies of the maps and profiles of surveys which have been made by this company, showing the practicability of the proposed routes and works, with some photographic views of the Mesilla Valley; also, a copy of the bill introduced in the last Congress, with a report made in its favor by the House Committee on Agriculture; also, arguments before the Senate Committee on Agriculture, which committee gave the measure most favorable consideration, without action, near the close of the last session.

The following papers were received by the committee and ordered filed for publication.

STATEMENT OF EDWARD F. HOBART, UNITED STATES SURVEYOR-GENERAL OF NEW MEXICO.

The Committee on Irrigation of the United States Senate:

GENTLEMEN: New Mexico is, by reason of its inland situation, naturally an arid region. This condition is however greatly modified by its mountains, which cover a large part of the northern portion of the Territory and are scattered over the rest of its surface in detached groups.

If these natural reservoirs of moisture were supplemented by works that can be readily constructed by man, a very large portion of what is now a barren waste could be turned into a very garden of the Lord, for at the touch of water these prairies become equal to the most fertile land in the world, and the crop is much surer than it can be where it depends upon rain.

From the mountains a great number of streams run out onto the plains of New Mexico.

The water that runs in these streams during the summer is used to some extent for irrigating the bottom lands; the water that runs during the rest of the year goes to waste.

For an example of these streams, take the little river Gallinas, which runs through Las Vegas, the flow of which I have measured at Las Vegas Hot Springs for the last six years.

The stream commences to rise from the melting of the mountain snows early in April, and soon attains a depth of 1 foot more than that of its ordinary stage; as the weather gets a little warmer this increases to 2 and then to 3 feet and two years ago last spring it reached the extreme height of 8 feet above low-water mark, which in a swift running mountain stream is quite remarkable.

The high stage of water in the spring continues about two months. Taking the average height during this time as 2 feet and the width as 30 and the velocity as 4 miles, there flows by every day a body of water 100 miles long, 2 feet deep, and 30 feet wide, or more than enough to irrigate a square mile of land for a year after all allowance is made for evaporation during the time it needs to be held. Therefore during the two months ending the middle of June ample water for irrigating 60 square miles of land could be saved up by the proper reservoirs.

For miles above Las Vegas Hot Springs the river enters a cañon 100 feet deep, 75 feet wide at the bottom, and 200 feet at the top. A dam constructed here at an expense of some $30,000 would hold the before-mentioned water, which could be let down as it was needed on the land.

The area of land to be irrigated could also be greatly increased by smaller reservoirs on the prairie, costing from $500 to $3,000 each. For example, 2 miles out on the

prairie, from the point where the Gallinas leaves the mountains, a flat valley on elevated ground could be crossed by an embankment 24 feet high in the center, containing 13,000 cubic yards of earth, and costing $1,500. This would produce a storage lake half a mile in diameter and of an average depth of 10 feet.

Four miles north of the Gallinas is a smaller stream; 10 miles north of the Gallinas is a Sapello of equal volume; 8 miles farther north is the Mora, and so on. Everywhere streams come forth from the mountains at frequent intervals, and if the water was saved it would irrigate a belt of land all along the foot of the mountains from 10 to 20 miles in width. How many thousands of happy homes would cover these tracts now barren and useless.

The same method of treatment just suggested continued to the streams along the upper Rio Grande would solve the problem for that river.

In the side cañons of the river at the north the waters should be held that now come down in devastating floods, and when the water becomes scarce a steady flow could be secured by releasing the water from the artificial lakes. The experiment made by the Government on the upper Mississippi shows that such a plan is practicable. It is what our country needs, and is beyond the power of private enterprise. It is for the general good, and will render valuable a vast quantity of Government and. Therefore we ask the aid of the General Government.

FROM COMPILED LAWS OF NEW MEXICO.

ACEQUIAS OR IRRIGATING DITCHES.

[Filed by Governor I. Bradford Prince.]

Title 1, *Chapter* 1.

SECTION 1. No inhabitant of this Territory shall have the right to construct any building to the impediment of the irrigation of lands or fields, such as mills or any other property that may obstruct the course of the water; as the irrigation of the fields should be preferable to all others.

SEC. 4. In case a community of people desire to construct a ditch or acequia in any part of the Territory, and the constructors are the owners of all the land upon which said ditch or acequia is constructed, in such case no one shall be bound to pay for said land, as all the persons interested in the construction of said ditch or acequia are to be benefited by it.

SEC. 5. The course of ditches or acequias already established shall not be disturbed.

SEC. 6. All rivers and streams of water in this Territory, formerly known as public ditches or acequias, are hereby established and declared to be public ditches or acequias.

SEC. 7. From and after the publication of this act, it shall be the duty of the several justices of the peace of this Territory to call together, in their respective precincts, whenever it may be deemed convenient, all the owners of ditches or acequias, as well as the proprietors of lands irrigated by any public ditch or acequia, for the purpose of electing one or more overseers for said ditches or acequias for the same year.

SEC. 10. The regulation of ditches or acequias which have been worked shall remain as they were made and remain up to this day.

SEC. 15. All acequias, public or private, when completed, shall be the property of the persons who may have completed such acequias or ditches, and no person or persons who may desire to use the waters of such acequias or ditches shall be allowed so to do without the consent of a majority of the owners of such acequies or ditches, and upon payment of a share proportionate to the primary cost of such acequia or ditch to the amount of the land proposed to be irrigated, or the quantity of water proposed to be used: *Provided*, That the provisions of this section shall not apply to any acequias or ditches, public or private, that may pass from the limits of any one county to within the lines of any other county.

SEC. 16. Where any acequia or ditch, public or private, passes from within the limits of any one county to within the lines of any other county, such acequias or ditches, within the proper precincts of their respective counties, shall be under the exclusive control and management of the officers of such precincts and counties.

SEC. 17. All the inhabitants of the Territory of New Mexico shall have the right to construct either private or common acequias, and to take water for said acequias

from wherever they can, with the distinct understanding to pay the owner through whose land said acequias have to pass, a just compensation taxed for the land used.

SEC. 18. If the owner or owners of land where a new ditch for an acequia is to be made should ask an exorbitant price as a compensation therefor, which shall not be satisfactory to the owner or owners of such acequia, it shall be the duty of the probate judge of the county in which it may occur to appoint three skillful men of well-known honesty to make an appraisement thereof and fix the compensation, which once done shall be executed and without appeal.

SEC. 24. In each precinct of this Territory, where public necessity requires it, an election shall be ordered and held on the third Monday of February, 1880. for the respective directors of acequias, for each one of such acequias as shall irrigate different places, as hereinafter provided.

SEC. 25. The manner of conducting the election, and the number of overseers, shall be regulated by the justice of the peace of the precinct, and the only persons entitled to vote at said election shall be the owners or renters of lands irrigated by said ditches or acequias.

SEC. 26. It shall be the duty of the overseers to superintend the repairs and excavations on said ditches or acequias; to apportion the persons or number of laborers furnished by the proprietors; to regulate them according to the quantity of land to be irrigated by each one from said ditch or acequia; to distribute or apportion the water in the proportion to which each one is entitled, according to the land cultivated by him, also taking into consideration the nature of the seed, crops, and plants cultivated, and to conduct and carry on said distribution with justice and impartiality.

SEC. 29. The pay and other perquisites of the overseers shall be determined by a majority of the owners of the land irrigated by said ditch or acequia.

SEC. 35. All persons interested in a common ditch or acequia, be they owners or lessees, shall labor thereon in proportion to their land.

SEC. 36. All owners of tillable land shall labor on public ditches or acequias, whether they cultivate the land or not.

SEC. 37. It shall be the duty of the proprietors to furnish each one the number of laborers required by the overseer, at the time and place he may designate, for the purposes mentioned in the foregoing section, and for the time he may deem necessary.

SEC. 48. The penalties on those who shall fail to supply the amount of work due by them, according to the provisions of this act, or the number of laborers on them apportioned, or for any violation of existing laws on this subject; and those penalties that are applicable under existing laws to major-domos shall be the same that shall be applied in these cases, and they shall be executed and fines shall be disbursed in the same manner.

SEC. 49. All currents and sources of water, such as springs, rivers, ditches, and currents of water flowing from natural sources in the Territory of New Mexico, shall be and they are by this act declared free, in order that all persons traveling in this Territory shall have the right to take water therefrom for their own use and that of the animals under your charge: *Provided*, That the word traveler shall not in any manner extend to persons who travel with a large number of animals, for in that case they shall not use the water of any spring belonging to any individual without having first obtained the express consent of the owner: * * * *Provided further*, That this shall in no manner apply to wells in this Territory: *Provided further*, That this act shall not be applicable to ponds or reservoirs of water that persons may construct for their own proper use and benefit, and no person under pretext of title to said sources, springs, rivers, or ditches shall have the right to embarrass and hinder or molest any transient person or traveler in or at the time of taking the water for his proper use and giving water to his animals.

SEC. 52. It shall be the duty of the major-domos of ditches and the commissioners of the same to prosecute all persons who shall violate the provisions of this act.

Title 18, *Chapter* 1.

SECTION 1305. The different communities or Pueblos of Indians residing within our settlements shall be subject to render their services in working the acequias and highways in which they have the common use of the water of said acequias with the immediate citizens to their Pueblos, and enjoy at the same time the benefit and commercial traffic: *Provided*, That in such service they shall be entirely subject to the laws now in force on both branches of roads and acequias.

In addition to the foregoing there prevails among the Pueblo Indians of New Mexico the custom of annually electing a mjaor-domo by all interested. He has control over the distribution of the water and calls out the help required for repairs, etc., much in the same manner as practiced among the Mexicans.

MINING AND WATER RIGHTS.

Section 5, article 14, adopted as part of the proposed State constitution by the constitutional convention which met at Santa Fé, N. Mex., September 3, 1889.

Whenever by priority of possession rights to the use of water for mining, agriculture, manufacturing, or other purposes have vested and accrued the possessors and owners of such vested rights shall be maintained and protected in the same, and the right of way for the construction of ditches and canals for the purposes herein specified is acknowledged and confirmed subject to the restrictions of this constitution as to taking property for public or private use.

LIST OF WATER AND IRRIGATION INCORPORATIONS.

[Filed by the Secretary of Territory.]

Albuquerque Consolidated Water-Works Company.
The Albuquerque Land and Water Company.
The Albuquerque Mountain Water Company.
The Aqua Pura Company of Las Vegas.
Albuquerque Water-Works Company (consolidated).
Albuquerque Water-Works Company (The A Mountain).
The Albuquerque Water Company.
The Albuquerque Water-Supply Company.
The Albuquerque Water-Works Company.
The Cerrillos Gas and Water Company.
The Cerrillos Gas and Water Company.
The Cerrillos Gas and Water Company.
Citizens' Water-Works Company.
La Campania de Agua Cristalina de Manantial.
The Deming Artesian Water Company.
The Dark Cañon Water Company.
The Deming Water-Works Company.
The Gavilan Ditch and Water Company.
Gallinas Canal and Water-Storage and Irrigation Company.
Gila River Ditch and Water Company.
Hot Springs Water-Works and Railway Company.
Kingston Irrigating, Mining, Milling, and General Water-Supply Company.
Kingston Water Company.
Las Cruces Water-Works Company.
The Lordsburg Water-Works.
Moreno Water and Mining Company.
The New Mexico Water Company.
Pecos and Placer Water-Pipe Company.
The Raton Water Company.
The Roswell Water Company.
The Santa Fé City Water-Works.
The San Juan Water Company.
Sandia Water Company.
Santa Fé Water-Works Company.
The Santa Fé Water and Improvement Company.
Silver City Water Company.
Sierra Madre Water, Mining, and Reduction Company.
Silver Madre Water, Mining, and Reduction Company.
Socorro Water Company.
The Springer Water Company.
The Springer Water-Works and Railway Company.
Tuerto Water Company.
The Water and Improvement Company.
New Mexico Water and Immigration Company.
New Mexico Water and Irrigation Company.
The Silver City Water-Works.
Socorro Water-Works Company.
Albuquerque Ditching and Irrigation Company.
Albuquerque Irrigating and Ditch-Improvement Company.
Albuquerque Irrigating, Canal, and Land Company.
Albuquerque Irrigating, Canal, and Land Company.
Animas, La Plata and San Juan Irrigating Canal Company.
Bernalillo Ditch and Irrigating Company.
Black River Ditch Company.
The Bowman Irrigation Company.
Black River Ditch Company.
B. R. Cañon Ditch Company.
The "B. R." Cañon Ditch Company.
The Cabresto Ditch and Irrigation Company.
The Chama Valley Mill and Irrigating Ditch Company.
The Detroit and Rio Grande Reservoir and Pipe Line Company.
Echo Irrigating Ditch Company.
Eureka Irrigating Ditch Company.
The Guadalupe Valley Irrigating and Milling Company.
McDermott Irrigating Ditch Company.
McDermott Irrigating Ditch Company.
Mesilla Valley Irrigation Company.
The Mountain Irrigation Company.
The New Mexico Irrigating and Land Company.
The People's Ditch and Irrigation Company.
The Pecos Irrigation and Investment Company.
Penasco Tank, Irrigating and Ditch Company.
Reservoir Irrigating Company.
Rio Grande Irrigation and Colonization Company.
The Rio Grande Irrigating Canal, Land, and Live Stock Company of New Mexico.
The Rio Grande Irrigating and Improvement Company.
The Rio Grande Irrigation and Ditch Company.
Santa Fé Irrigation and Colonization Company.
The Santa Cruz Land and Irrigation Company.
Socorro County Irrigating and Agricultural Improvement Company.
The Socorro Ditch and Irrigating Company,
The South Spring River Land and Irrigation Company.
Una de Gato Canal and Irrigating Company.
Water Cañon Stock and Irrigating Company.
Western Union Cattle, Land and Irrigation Company.
New Mexico Irrigation Company.
New Mexico Irrigating Canal Company.

DITCH COMPANIES.

American Bend Ditch Company.
Bosque Grande Ditch Company.
The B. R. Cañon Ditch Company.
The Dark Cañon Ditch Company.
The Farmers' Ditch Company.
The Fort Sumner Land and Ditch Company.
Fresnal Ditch and Improvement Company.
George Danner Ditch Company.
Good Bend Ditch Company.
Greylands Ditch Company.
The Guadaloupe Valley Ditch Company.
Hondo Falls Ditch Company.
The Island Crossing Ditch Company.
The Largo Land and Ditch Company.
LaPlata Indian Ditch Company.
Lea & Cockrell Ditch Company.
The Lincoln County Ditch Company.
Lower Felix Ditch Company.
Mimbres Ditch and Pipe Line Company.
The Mimbres Canal Company.
Mimbres River Canal Company.

Valley Canal Land and Improvement
ıy.
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h Spring River Ditch Company.
West Ditch Company.
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s River Ditch Company.
Placer Mining and Ditch Company.
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lley Ditch Company, of Lincoln County,
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s Valley Land and Ditch Company.
tch Company.
o Ditch Company.
and Salt Lake Ditch Company.
rside Ditch Company.
Arzul Ditch Company.
de Ditch Company.
Rio Hondo Ditch Company.
The Rio Grande Placer Ditch Company.
Rio Grande Pecos and Ortiz Grant Canal Company.
Rio Pecos and Salt Lake Ditch Company.
Rock Corral Ditch Company.
San Jose Ditch Association.
San Juan South Side Canal Company.
The San Juan Canal Company.
The San Juan Land and Canal Company.
San Antonio and Placer Mining and Ditch Company.
The San Simon Cattle and Canal Company.
The Spring Valley Ditch Company.
The Union Ditch Company.
Rio Grande Valley Water Company.
The La Plata Ditch Company, of Colorado.
Jacarilla Mining and Water Company.

MENT OF GEORGE M. KELLOGG, M. D., OF DEMING, N. MEX.

rd, even of an out-door naturalist, can be needed to emphasize the importance
natter your committee has in hand. But as germane to the primary line of
estigation, I respectfully call your attention to another subject also deserv-
consideration of your body. I refer to the natural productions of these upland
id mountains, and would suggest an investigation as to the plant-life adapted
tal conditions here present—the vegetation which with a modicum of irri-
would prove the most profitable and satisfactory. It would be in place—an
as to the nature and value of products found in regions analogous to this, as
pes of Asia, the plains of Tartary, Persia, and Arabia. Many of the choicest
nedicines and condiments originated in those lands, and might with great ad-
be introduced here. There are many native products the collection of which
e valuable, and the best methods of their cultivation, where cultivation should
racticable, would constitute an inquiry of rare importance. I refer to such
the yucca or amoli, the mesquite, as tree or bush, and the cañaigre-plant, so
annin.
the Irish potato, as is now generally believed, originated in New Mexico, it
ach here in this land of sunshine, with but a modicum of irrigation, its highest
nent. There might be initiated the successful cultivation of medicinal rhu-
the best quality of gum-opium, which now are produced only in the high and
ns of the Eastern Continent.
egetation of these upland plains should be sedulously studied. There are
ees and shrubs which would flourish with a slight help from irrigation. It
which should be selected for the growing of timber and shade trees. I would
ze this because of some usages noticeable in this country, such, for instance,
ltivation of the cotton, wood, an enormous water consumer of little value as
r fuel. A species of black walnut, here indigenous, is well worthy of cultiva-
its fruit and timber. In the mountains where there is, in some places, an
f moisture, such trees as the cotton, wood are permitted to usurp the ground
rees a hundred times more valuable for shade, timber, and fruit might be
ith marked success.
it is considered that a majority of the medicinal plants and a large moiety of
ed by man as food, had their origin in the high and dry parts of the earth,
in western phrase, find "a pointer" to moderate our zeal in endeavoring to
the highly-watered alluviums in agricultural products.
is, in this country, an abundant plant, which seems, in flavor and from the
of thein, a fair substitute for China tea. Doubtless the tea plant itself might
here as well as some of the hardier varieties of Arabic coffee.
ld respectfully memorialize Congress to establish botanic gardens and labora-
or the thorough investigation of the native products of our country, and for
ful selection of the exotics adapted to the various sections. The fair returns
ng to the country from scientific fish-culture now fostered by the Government,
ragement for analogous work as to plant-life. And such work should be in-
ed before the utter extermination, as now threatened, of many valuable spe-

STATEMENT OF JOHN SYMINGTON, ACTING ASSISTANT SURGEON, OF FORT MARCY.

The Santa Fé River rises in the mountains north and east of Santa Fé, flows in a direction almost west, until it reaches the Rio Grande, distant some 30 miles. At present some 12,000 acres are under a high state of cultivation, the water supply being conducted by a system of ditches (many of which antedate the Spanish conquest) taken from the stream above the town. A thoroughly accurate test of the volume of water available has never been taken, as in addition to the numerous irrigating ditches derived from the river, a dam has been thrown across the river 3½ miles above the city, from which the town is supplied by mains, but a rough estimate of the volume of water flowing past a point below the last important ditch, will show that, could it be utilized a large portion of the 50,000 acres of land adjoining the valley could be brought under cultivation. Successful efforts to cultivate these lands have been made, and in all seasons of a fair rain-fall they have produced abundantly the usual cereals and some of the products of lower altitudes. The soil being of a reddish loam and capable of retaining moisture, has induced the establishment of rude storage-reservoirs at points where the rain-fall from the adjacent foot-hills could be collected, and are made by throwing the earth on a cribbing of stakes, brush and bowlders, built in a circlular form, at the rim of which are planted willows, which in growing fill the interstices of the cribbing with a thick growth of roots, thus giving stability to the structure; the bottom is made impervious to water by driving cattle or, preferably, sheep around the inclosure until the earth becomes thoroughly packed to the depth of several inches, and many reservoirs so made have served the purpose of their construction for many years, without the necessity of repair or loss of water, save by evaporation. With each shower they are refilled, or their contents added to, and frequently insure the safety of a crop during a critical season.

These several enterprises show conclusively the feasibility of the scheme of water storage, as during the spring months the river is filled with water from melting snows, and in the latter part of July and August, at the time of the greatest precipitation, the stream often causes great damage to its banks from overflow. Of all this water not one-fourth is utilized, and it is the observance of this fact that induces me to believe the application of storage dams and ditches to keep them filled would be the means of reclaiming from 50,000 to 75,000 acres of valuable lands adjacent to Santa Fé, the greatest portion of which are subject to entry, and from their situation easily irrigated and capable of producing good crops, for which a ready market can be found in the adjacent growing mining towns of Cerrillos and San Pedro. Many natural sites for reservoirs exist, as in arroyos with rocky and precipitous sides, where no great cost would be incurred in their construction, and which would be filled from the rain-fall, and a succession of such reservoirs could be constructed, connected by ditches, which passing in close proximity to the foot-hills, would render auxiliary what water fell on them, as frequently showers do not extend to the plains.

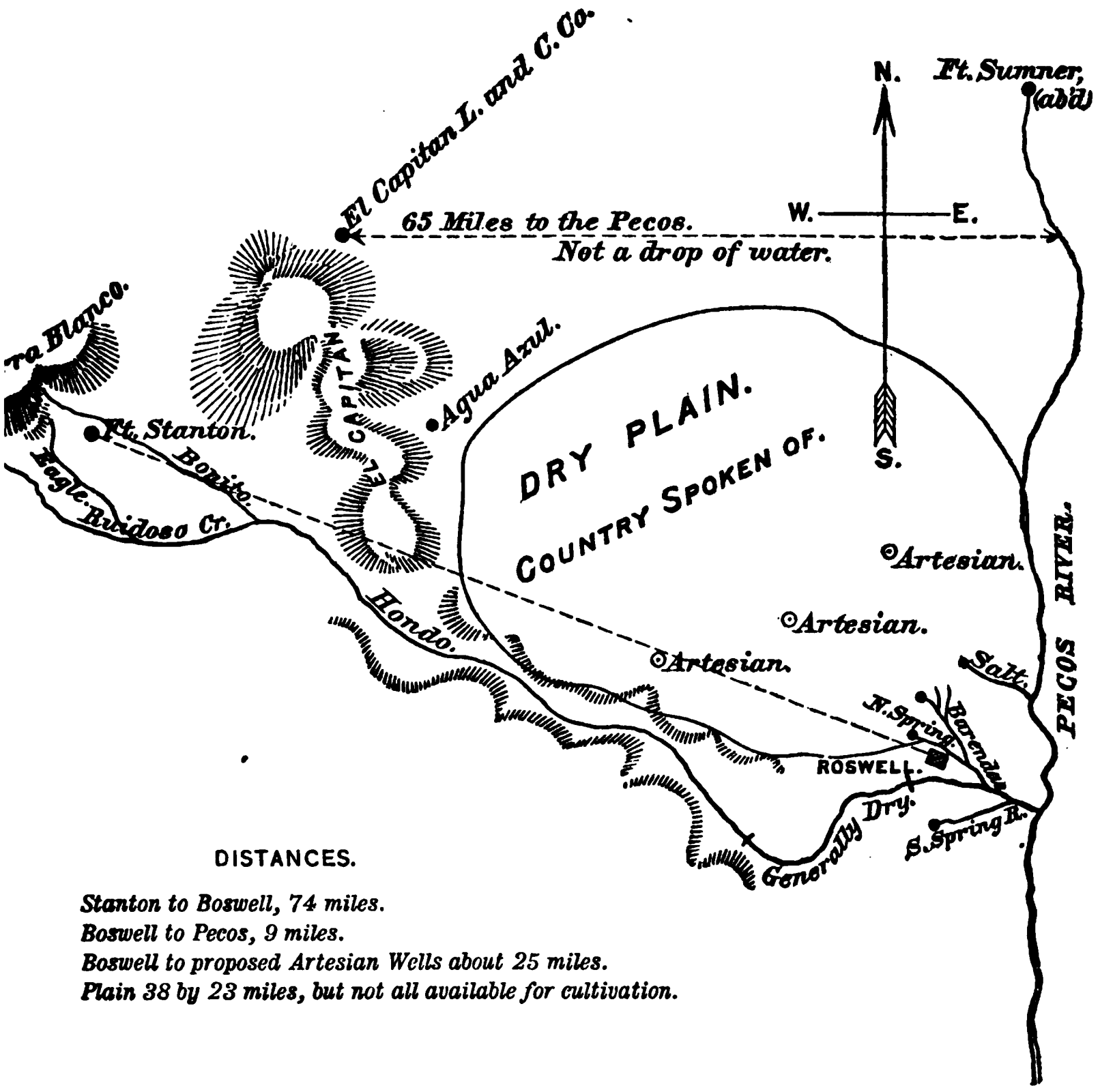
STATEMENT OF THOMAS CRUSE, FIRST LIEUTENANT, SIXTH CAVALRY, OF FORT STANTON.

There is, bordering on the Pecos, to the eastward of Fort Stanton, a plain about 30 miles wide, and wherever water has been put over the land the results are simply wonderful. The crops are varied, command excellent prices, and the fruits grow well, except semi-tropical varieties. Peaches and sweet-potatoes especially seem to be suited to that locality and thrive in the soil.

There is at present in the vicinity of Roswell, N. Mex., about 200,000 acres of the very finest land, that I think would be a good subject for discussion by the honorable commission, and some attempt on the part of the Government to reclaim. In my opinion, this can be most readily done by sinking, say, three artesian wells, 10 miles apart, in order to demonstrate whether or not water can be obtained in that way.

That the effort in that direction will be rewarded I am led to believe from the nature of the surrounding country and the very curious water system that exists in the vicinity of Roswell. This is seen in the rough sketch hereto appended. A word in explanation of the sketch. The El Capitan Mountain is very high and has snow on it; still there are no streams flowing from it. In the vicinity of Roswell no less than six good-sized streams gush from the surface of the almost level plain and flow into the Pecos, about 9 miles away. Enough water is obtained from these streams by irrigating ditches to cover about 60,000 acres. My idea is that one of the three artesian wells would tap the subterranean lake which feeds the large streams at Roswell, and I calculate *that $10,000* would settle the matter one way or the other. North Spring River

out 30 feet wide, 6 to 8 feet deep, and runs at the rate of 8 miles per hour. South
ng River is about the same size, and the three Barendas flow about one third as
h water.



DISTANCES.

Stanton to Boswell, 74 miles.
Boswell to Pecos, 9 miles.
Boswell to proposed Artesian Wells about 25 miles.
Plain 38 by 23 miles, but not all available for cultivation.

ATEMENT OF E. H. KELLOGG, ENGINEER OF THE MAXWELL LAND GRANT COMPANY OF RATON.

am in receipt of your favor of the 15th of June, with inclosure of letter from Mr. hard J. Hinton, expert of the Senate Committee on Irrigation, requesting informa- as to the irrigating enterprises in which your company has been engaged. I e pleasure in complying with the request, the more that the subject is one of deep rest to me, both as engineer and citizen, and I am confident that the results of investigation, by the collection and dissemination of valuable information, will omplish a very decided advance in the intelligent development of the Rocky Mount- region.

desire to preface my report with the remark, that within the year during which ve been engaged on the irrigation systems of the Maxwell Grant the time has n almost wholly devoted to construction and so little of it to practical operation, t I shall be unable to answer many of the most important questions out of my own erience, except so far as experience under parallel conditions elsewhere enables to speak with certainty.

he Maxwell Grant occupies the north central portion of New Mexico, and em- es an area of 1,714,000 acres of mountain and prairie land, with a border on the t of a range of mountain peaks, many of which reach an elevation of nearly 14,000 above the sea. Between this range and the plains lies a broad band of foot-hills, ich but for their nearness to the main range would rank as mountains. This re- n is generally covered with heavy timber of pine, spruce, cedar, and piñon. Near headwaters of the main streams which drain this area are numerous open parks greater or less extent. The foot-hill belt ceases abruptly at the western edge of

the plains, sharply defining the limits of the two topographical extremes—prairie and mountain. Through their several cañons a number of water-courses discharge the accumulated rain-fall of the hill region and through the leading channels into the main artery—the Red or Canadian River.

The prairie lands have till now been utilized only as grazing lands, while their agricultural possibilities have been wholly ignored. The signal success which has attended the efforts to redeem the so-called arid lands of Colorado encouraged the owners of this grant to inaugurate a system of irrigation works with a view to increasing the productive, and necessarily the selling value, of lands till then of nominal value only. In pursuance of this plan surveys were made, and all available data concerning water supply, climate, soil, etc., were collected. These latter were meager enough, since no systematic record had been kept and the reports of the oldest inhabitant were tinged by the extent to which he had been prosperous or afflicted in the time covered by his residence here. Some were so impressed by the drought of a certain year as to be unable to recall an offsetting wet one. Others could only remember those years when abundance of rain made irrigation unnecessary. From the average of this curious medley of reports the opinion was reached that the mean annual precipitation here was not less—probably greater—than that of regions where successful agriculture is practiced in Colorado and Utah, and that if even a decent moiety of this water could be saved, a very large body of land could be reclaimed.

With no more definite facts than these it was decided to proceed. As a result we have the two completed systems definitely described below. First:

THE SPRINGER SYSTEM.

This system draws its supply from the Cimarron River, at a point 13 miles northwest of the town of Springer. It begins with a canal 20 feet wide on the bottom, with slopes of 1 to 1 and a fall of 5.28 feet per mile, capable of carrying a depth of 4 feet and discharging approximately 400 cubic feet of water per second. At the end of 6 miles a branch is diverted, and conducted in a flume down to the first of a series of natural lake beds 90 feet below the main ditch. These lake beds are arranged by nature so that water can be drawn through the whole chain to the lower (No. 6) by the simplest means. No. 7 (see plat) is artificial, being formed by an embankment across a low valley. From this in turn a ditch 10 feet in width carries water to the lands about Springer.

From the point of first departure the main line is reduced to 12 feet in width, but increased in fall to 7.6 feet per mile, following a ridge or divide, which necessitates several "drops" of simple but novel construction. This is called the "High Line," and is about 8 miles long. Continued under the name of the North High Line about 13 miles, and gradually reduced from 10 to 6 feet in width, the Red River Valley is reached.

The system as now completed consists of 47 miles of main and distributing ditches, four reservoirs of 40 acres each, averaging 6 feet in depth; one of 62 acres, 6 feet deep; and one of 475 acres, 9 feet deep. The entire plant is designed to serve 20,000 acres with competent irrigation. The total cost of this plant will be approximately $60,000, or $3 per acre, on the land redeemed.

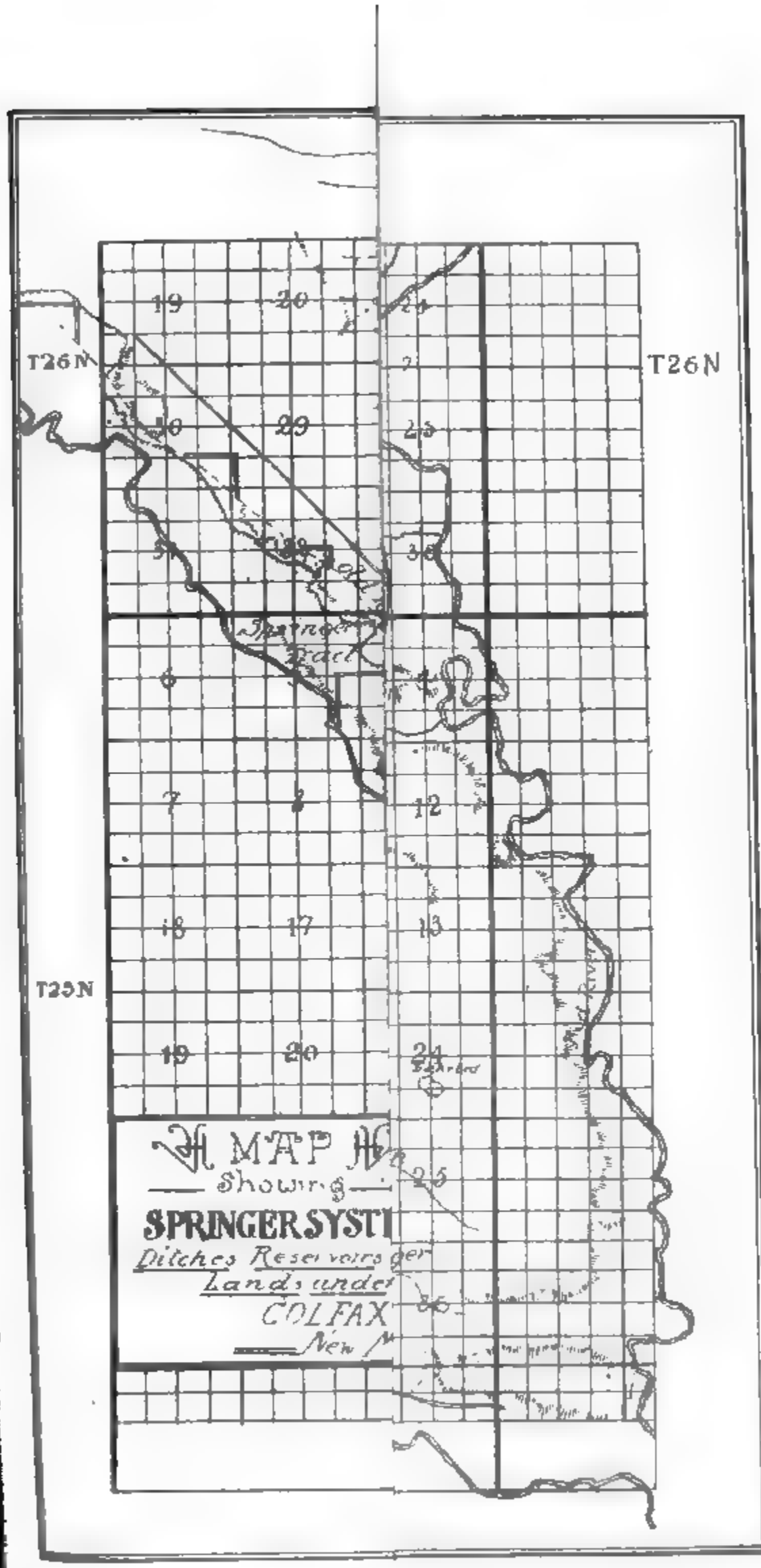
The details of construction are of the simplest order; lines are laid in tangents and regular curves; banks are built 2 feet above high-water mark, with bermes of 4 feet; wood-work is substantially framed and coal-tar is used liberally on all bearings. The outlet to the large reservoir is a masonry conduit with two iron valve-gates and flap-gates at head for emergencies; heavy masonry bulk-heads are erected at head and foot of conduits. The embankment is built with a width of 12 feet on top, inner slope 3 to 1, outer slopes 1½ to 1. It is 4,000 feet long and 28 feet high at highest point; overflow weirs at either end each 16 feet in width, 2 feet below high-water mark and 8 feet below top of bank, insures against any possibility of surcharge.

THE VERMEJO SYSTEM.

The Vermejo system is essentially one of storage. The main canal (20 feet wide on bottom, 4 feet deep, fall 5.28 feet per mile) taps the Vermejo River near John B. Dawson's house, above the mouth of the Vermejo Cañon, and at the end of 9 miles begins to feed lakes Nos. 4, 5, 6, 7, and 8; at 12 miles it flows through lake No. 1, and at 13 miles discharges into the Laguna Madre. At the ninth mile the width is reduced to 18 feet; at the eleventh mile to 16 feet, and the grade doubled.

In this line there are five drops, aggregating nearly 100 feet in all, but in two cases the water is allowed to run wild over the sod. The essential feature of the wooden drops is the tub sunk below the lower level in which all the turmoil of falling water is exhausted.

Water is drawn through the Laguna Madre into main laterals to the north and *south; former supplies* Laguna Rodondo, Moccasin Lake, and Nos. 15, 13, 14, and 18,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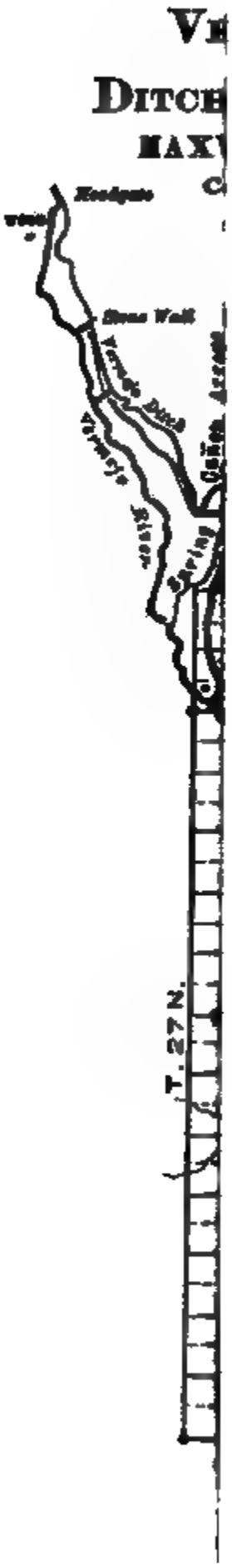
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The south lateral runs south about 3 miles and then unites with a lateral from the chain of lakes first mentioned. This arrangement places the lands south and east under seven lakes. Enough of the lateral system and lake improvement has been done to supply all demands for this year. The only novelty in the way of construction on this system is in the employment of wood pipe running under vicious ravines instead of overhead flumes. These pipes are 6 feet in diameter, and are constructed at the place where they are used of staves of Texas pine, banded with steel rods, 10 to 18 inches apart. Sufficient fall is given between receiving and discharging ends to insure a powerful flow. Floods pass harmlessly over these pipes, and being thoroughly painted inside and out with coal-tar, are very durable. I estimate their life at twenty years. At the seventh mile of the main line, and at the head of the second drop, a high line lateral, 8 miles in length, carries water to Crow Creek.

This system is designed to serve 30,000 acres of land, although the river is somewhat smaller than the Cimarron; the remarkable number and sizes of the natural storage basins scattered over the tract making this increase of service possible. All the eighteen lakes will be re-enforced by embankments at an early day, and their capacity fully doubled. The total cost of construction to date is, approximately, $56,000, or $1.87 per acre. This cost is considered phenomenally low.

SUPPLY.

The Cimarron and Vermejo Rivers head against the main range, but many important branches run into them from the foot-hill country north and south. The total area of mountain country drained by these river is, approximately, 250,000 acres. A very considerable part of this area is subject to very heavy falls of rain and snow, which, except on occasional "off years," insure a very large and steady flow, besides many severe floods. The climatic habit of the region seems to be fairly defined. An early spring thaw, supplemented by rain and soft snow, mark the months of February, March, and April as a high-stage period; May and June are generally destitute of rain, but the extra heat attacks the snow reserves, and the high stage is fairly maintained. During July and August frequent rains may be expected, making the lessening river flow of small importance to the farmer. September and October are bright, open, and dry, and enough water to complete the last watering of meadows and fruit-trees can be pretty safely relied upon. Neither of the streams mentioned has been systematically gauged, and their variable flow makes estimation little better than guess-work. In 1888 the Vermejo held its high stage from May 1 to August 1, and low water was not reached till September. During the same year the Cimarron maintained a strong flow throughout the season. So far this year, owing to the absence of snow in the mountains, there has been no rise of any consequence in the Vermejo, though the Cimarron ran strongly from February 15 to May 1. It is now even lower than the Vermejo.

SOIL.

The soil is very uniformly a close-grained clay, of great depth; it is easily saturated, and retains moisture excellently. In point of fertility the new experiments on the Maxwell farm, on the Vermejo, promise nobly. Alfalfa and almost all kinds of grain, large and small fruits, and vegetables, are in excellent condition, and the showing is remarkable for entirely new land.

DUTY OF WATER.

On this subject much has been said and written, more or less directly to the point, but the very great diversity of opinion arising from the almost infinite variations of conditions of soil, climate, crops, and seasons, as well as the degrees of intelligence with which water is applied, make it impossible to formulate any standard gauge. Our experience on the Maxwell grant is too young yet to give us any definite or reliable data. It is, therefore, only an opinion of my own that 1 cubic foot per second, flowing constantly through the irrigating season, will serve 40 acres the first year, 50 acres the second and third, 60 the fourth, with a possible rise to 80 acres under the best conditions. It would be quite safe, I believe, to set the figure at 60 acres, for an average of a number of seasons.

STATEMENT OF THE RIO PECOS IRRIGATION AND CANAL ENTERPRISES.

The Rio Pecos rises in the northern part of New Mexico, northeast of Santa Fé.

It flows in a southeasterly direction to the neighborhood of Fort Sumner, and then a little east of south across the territorial line into Texas, finally forming a junction with the Rio Grande.

It is a mountain stream, subject to alternate flood and drought, until it reaches the neighborhood of Roswell, N. Mex.; thence for 100 miles, in a due south line, it runs a tortuous course of probably 250 miles, receiving at intervals large quantities of spring water.

These springs generally flow into it along its bed, following the general limestone strata of the country.

They represent the drainage from the eastern slopes of the Capitan, Sierra Blanca, Sacramento, and the Guadalupe Mountains, and the waters of the upper river which disappear below Fort Sumner.

Careful measurements show that the permanent supply is sufficient to fill both of the canals now in course of construction, and calculated to carry 1,600 cubic feet per second, or 80,000 miners' inches.

The drainage area, or catchment basin of the Rio Pecos, within the Territory of New Mexico, and available for irrigation purposes, is approximately 20,000 square miles, at varying altitudes from 3,000 to 11,000 feet, and extending across four degrees of latitude from the thirty-second to the thirty-sixth parallel.

The lands of the valley between Roswell and the territorial line, subject to irrigation, are of the choicest limestone soil, and the total area between the foot-hills on the west and the river, is nearly or quite 1,000,000 acres. Of this fully 400,000 acres is below the level at which it is practicable to deliver water from the Pecos.

The 40 miles of the Northern canal, now under contract, will cover about 75,000 acres of bottom and mesa land, and more than that area can be covered by extending the canal farther south.

The Southern canal is much the larger one, and will irrigate more than 100,000 acres on the west side of the river, north of the Texas line, while there is practically unlimited area that can be made available, by extending south of that line. Several bodies of choice land can also be covered on the east side of the river if desirable.

These lands are, for the most part, covered only with the scant growth of gramma grass.

Where the greasewood is found it is not in the way of the plow, and the roots of the mesquite more than compensate for the grubbing, where that occurs.

The surface needs no leveling for the distribution of water. The natural slopes to the west, toward the river and to the south, are just enough to afford every facility and to make the practical work of irrigation quite inexpensive.

The Northern canal is being constructed 30 feet wide on the bottom, with sides sloping 1½ to 1 foot, and to carry water 5 feet deep, taking its supply from the Hondo, the principal tributary of the Rio Pecos, below the junction of the North Spring and Barenda Rivers, deriving its chief supply from permanent springs of great volume. Three miles from its head it crosses and receives the waters of the South Spring River, and is deepened to 6 feet to accommodate the increased supply at that point. These streams are all fed by permanent springs.

The Southern canal was constructed a distance of 11 miles by the company from which it was purchased by this company, with the capacity to irrigate 30,000 acres. It is being enlarged to 45 feet wide at bottom, 63 feet at the top, and 6 feet deep, and by careful computation is intended to utilize all the available water of the river during the entire irrigating season. Its length within New Mexico will be 55 miles.

It is taken from the east side of the Rio Pecos a few miles below Seven Rivers. Although the waters of the Pecos are sometimes enlarged by floods, at the point where this canal is taken from the river, a dam 3 feet high, built at trifling expense, suffices to turn the water to fill the canal. It is controlled by head-gates, and the fall of the river is so great at that point that the rise does not exceed 6 feet—indeed, it never gets out of its banks. The river is a succession of rapids, and the fall within 6 miles amounts to as much as 50 feet. Very much of the water can be utilized at the crossings of arroyos for water-power, and then be discharged so as to cover large areas of agricultural land, without any loss of water. The canals are secure from floods. On the Hondo the reservoir at the dam backs fully half a mile up-stream, making dead water, and giving perfect control.

The price of water rights has been fixed for the first 20,000 acres at $10 per acre—one-tenth cash and the balance in annual payments of $1 per acre. The next 10,000 acres will be sold at $12.50 per acre; and after that none will be sold for less than $15 per acre. The annual water rent has been fixed at $1.25 per acre for cultivated land, and 50 cents per acre for uncultivated land, one-half payable June 1st, and the *other half payable* December 1st of each year.

STAKED PLAINS AND PAN HANDLE (TEXAS) DIVISION.

ON TRAIN AT PECOS, TEX., *September* 9, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF R. K. BRANT, OF PECOS.

The CHAIRMAN. Have you a paper which you desire to present to the committee?

Mr. BRANT. I have a resolution which, though it was not signed by the governor, was passed by the legislature.

It is as follows:

IRRIGATION RESOLUTION.

Concurrent resolution addressed to Senators and Representatives in Congress for passage of such laws as may be necessary to adjust and regulate the rights of citizens of several of the Territories and the State of Texas in the use of waters of interstate streams.

Whereas several rivers having their sources in New Mexico and other Territories flow into and through the State of Texas; and

Whereas the waters of said streams are necessary for irrigation in the arid districts of Texas; and

Whereas it is expedient to obviate future litigation by providing for an adjustment and regulation of the rights of the respective citizens of said State and Territories entitled to the use of said waters for purposes of irrigation: Therefore,

Be it resolved by the legislature of the State of Texas, That our Senators and Representatives in Congress be requested to secure the passage of such laws as may be necessary to effect the objects above set forth.

[Indorsed.]

Concurrent resolution to request our Senators and Representatives in Congress to secure the passage of laws to define and regulate the rights and privileges of citizens of several of the States and Territories and the State of Texas respecting the use of waters of interstate streams.

Adopted by the Senate February 13, 1889.

C. M. BOYNTON,
Secretary of Senate.

Received from the Senate February 14. Taken up, read first and second times, and adopted.

W. M. IMBODEN,
Chief Clerk House of Representatives

THE STATE OF TEXAS,
Department of State:

I, J. M. Moore, secretary of state of the State of Texas, do hereby certify that the within and foregoing is a true copy of the original concurrent resolution adopted by the twenty-first legislature of the State of Texas, at its last session, which adjourned on April 6, 1889, entitled "Concurrent resolution addressed to Senators and Repre-

sentatives in Congress, for passage of such laws as may be necessary to adjust and regulate the rights of citizens of several of the Territories and the State of Texas in the use of waters of interstate streams;" the said original being now on file in the archives of this department.

Witness my official signature and the seal of State affixed, at the city of Austin, this 2d day of September, A. D. 1889.

[SEAL.]

J. M. MOON,
Secretary of State.

Mr. BRANT. I have also a paper showing the number of canals and their lengths owned by the Pioneer Canal Company in Reeves and Howard Counties.*

There is a small company taking out 50 feet of water by a canal 35 miles long. Then there is a company north of here.

The CHAIRMAN. Have you examined the mountains here to see what the chances are for increasing the supply of water by storing?

Mr. BRANT. I have been in those mountains, and I have no question that reservoirs can be made in the high peaks.

The CHAIRMAN. In the mountains you have flat places where there have been lakes, which discharges through a narrow cañon?

Mr. BRANT. No, I do not call to mind any particular situation of that kind, but I am satisfied they exist.

The CHAIRMAN. You estimate that with the natural flow of the streams you can bring under cultivation how many acres?

Mr. BRANT. Sixty-four thousand acres.

The CHAIRMAN. You think you have enough water for that?

Mr. BRANT. We are the first on the stream, and we can get that if we get our appropriation. Every gallon of water I know is valuable. Our statutes provide for an economical use—a very good way. The consumer does not want to waste the water. There is no disposition on the part of anybody to waste it.

Senator REAGAN. Will you furnish the committee a copy of the laws on irrigation?

Mr. BRANT. Yes.

The CHAIRMAN. How about artesian wells?

Mr. BRANT. We have a fine artesian belt here. Wherever we put down a well we get a flow from 212 to 350 feet. There are about eight or ten wells around this town.

The CHAIRMAN. Have you noticed any diminution in the flow on account of the number of wells that have been sunk?

Mr. BRANT. No; never.

Adjourned.

ON TRAIN AT COLORADO, TEX., *September* 9, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman) and Reagen; also Director Powell.

STATEMENT OF FRANK E. ROESLER, OF DALLAS.

The CHAIRMAN. What is your occupation?

Mr. ROESLER. Secretary to the Marienfeld Fruit Growing, Gardening, and Irrigation Company; also emigration agent of the Texas Pacific Railway.

The CHAIRMAN. Have you given much attention to the subject of irrigation in Texas?

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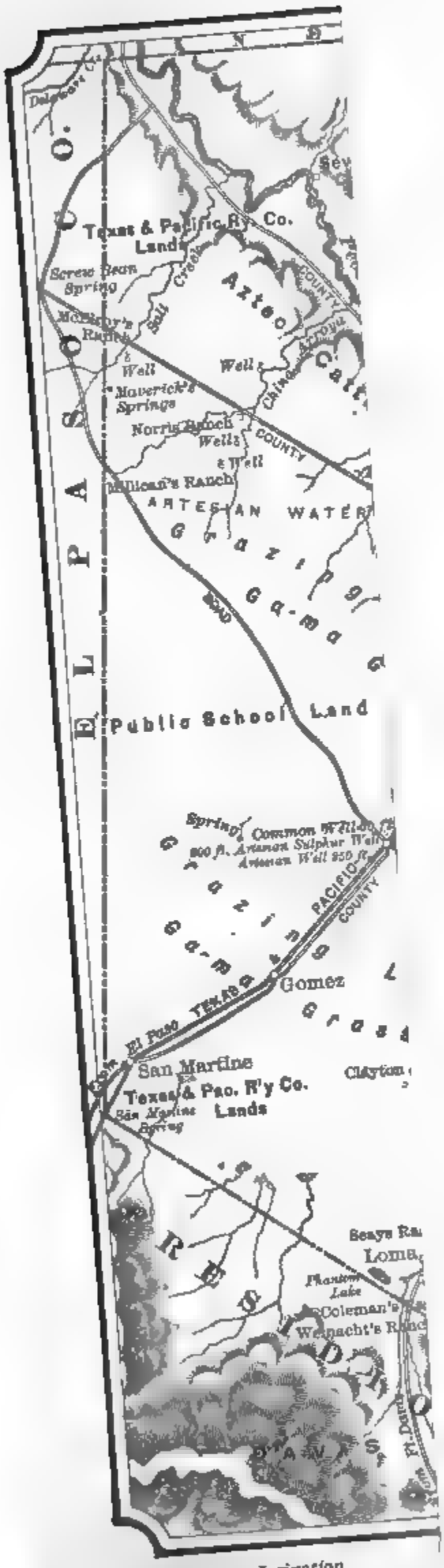
* *The paper referred* to will be found on pages 54 to 57 of this volume.



Report on Irrigation.

Mr. ROESLER. Yes; I have given it considerable attention.

The CHAIRMAN. Have you reported upon the subject?

Mr. ROESLER. Yes; at various times.

The CHAIRMAN. Is the paper you present your report upon that subject?

Mr. ROESLER. Yes. There are also several other reports that were sent in at various times to Major Hinton, your engineer, which are now in his hands.

The CHAIRMAN. And those reports are all you wish to say about the subject?

Mr. ROESLER. Yes. I would like to add that the reports relating to irrigation published by the department heretofore, are of interest to this State.

The CHAIRMAN. What have you to say in reference to the benefits of engineers' surveys designating the points for reservoirs and making estimates of the cost of construction, etc.?

Mr. ROESLER. A survey of that sort would be of invaluable benefit.

The CHAIRMAN. Would it help to develop Texas?

Mr. ROESLER. Yes; very much. I would like to suggest that the nature of the surveys in this region should be to determine as far as possible: First, the amount and character of the visible water supply like that in the Colorado River, the Rio Grande and Pecos, the Delaware and Olympia Cañons, and a considerable number of small streams that are scattered through the arid regions of Texas. Second, after these, are a number of underground rivers which are known to exist, and could by a little effort be traced. Also in the western portion of Texas, including the Staked Plain, a number of ancient river beds are also worthy of survey, which are now filled with filth and sand, it being demonstrated in many places that water is found in them at a depth varying from 2 to 10 feet. A line of levels run at various places will show that this water now lying under this sand could be carried on to the neighboring uplands and be applied for purposes of irrigation.

The CHAIRMAN. What have you to say about a tank for storing storm waters?

Mr. ROESLER. Through all western Texas, particularly the mountain regions, there are numerous ravines which could be made suitable for storing storm water, which is now lost and useless. That this is practicable is proved by experiments. It is proved on the ranch of C. C. Slaughter, in Martin County, where at an expenditure of $1,700 he has created a tank or reservoir having a width of nearly a quarter of a mile, a length of nearly a mlle, and a depth varying from 6 to 20 feet. Much of the water in this tank was lost at first by seepage and by evaporation. It has been observed that the shallower the tank the greater the evaporation; but as the quantity of water augmented and the whole of it remained cooler, the evaporation grew less, and more water was secured. There are various places along the line of railroad where the embankment has crossed the ravine, and it has filled up above and formed lakes. Now, many of these dams could be built so that they would water a considerable area.

The following paper was then read by Mr. Roesler:

THE SUBHUMID REGION OF TEXAS AND ITS FACILITIES FOR IRRIGATION.

It is somewhat difficult in Texas to determine with any accuracy the boundaries of what might properly be called the arid, the semiarid, the subhumid, and humid areas. An arbitrary division by meridians will hardly hold good, because the rainfall varies much at different *points along* a meridian, and further the altitude is not

uniform along the same line. A record of the rain-fall, will hardly suffice, because the observations are of such recent date that they can not be said to be well established. The altitude of the various parts of the State in connection with the rain-fall record as far as observed, seems, therefore, the only available method of determining the boundaries of each area.

THE ARID PORTION OF TEXAS

can by this method be classed as that part of the State in which the altitude ranges between 3,000 and 6,000 feet and in which the rain-fall in a number of years varies between 10 and 17 inches; say all that part of Texas lying between the Pecos and Rio Grande Rivers, and in which farming is impossible, except by irrigation.

THE SEMI-ARID REGION

should by the same method be designated as that part of Texas having an altitude varying between 2,000 and 3,000 feet, and possessing a rain-fall of 17 to 30 inches per annum; enough in quantity to mature any crop, provided the rain-fall was timely and properly distributed, a section of country that will mature all kinds of forage plants to perfection, without resort to irrigation, and will produce good small-grain crops in favorable years, say four years out of six. An irregular line drawn from east boundary Hansford County, touching altitudes of 2,000 feet to the Colorado River in Mitchell County, and thence sontherly to the Rio Grande, would about indicate the east boundary, and the Pecos River the west boundary of the semi-arid region. This territory is more particularly described in a previous paper on the Irrigation of the Texas Staked Plain.

THE SUB-HUMID REGION

according to the same rule might be safely indicated as lying immediately east of the semi-arid region, its western boundary being described as the eastern boundary of the semi arid part of the State. It might, perhaps, be better described by saying, that it is an irregular line lying near the one hundredth meridian, crossing the same at various points, but seldom being more than 50 miles on either side. The eastern limit of the subhumid region might be shown by the irregular line trending southerly from the southeast corner of Montague County to San Antonio, passing by way of various points along that line having an altitude of about 1,000 feet above sea-level.

The rain-fall of the subhumid region as noted by the various Government and private observations, made during a series of years, is about as follows:

Brackettville, Kinney County, 29.12 inches; Coleman, Coleman County, 27.71 inches; Fort Concho, Tom Green County, 25.07; Decatur, Wise County, 28.63 inches; Fort Griffin, Shackelford County, 24.75; Fort McKavett, Menard County, 22.71 inches; Graham, Young County, 25.11 inches; Henrietta, Clay County, 22.73 inches; Jacksborough, Jack County, 26.20 inches; Fort Elliott, Wheeler County 28.38 inches; Baird, Callahan County, 22.37 inches.

The average rain-fall is 24.96 inches, as shown by the information at hand. The smallest precipitation was rated at Baird, in 1886, when the total rain-fall only amounted to 16 inches, and the greatest was rated at Fort Concho, Tom Green County, in 1885, when it amounted to 42.67 inches. It will be readily observed that in the matter of quantity, the subhumid region is as well provided for as are the best agricultural portions of the United States.

It does not appear that such crop failures as have been encountered were due in any measure to a lack of precipitetion, but rather to the want of discretion on part of the rainmaker in a proper distribution of the same. The conditions of the precipitation in Texas are peculiar and well defined.

The conditions of temperature, altitude, and direction of the winds determine the time as well as the quantity of the rain-fall in the various portions of the State, as may be readily observed from a study of its climatology. A mild winter in Texas almost invariably means a moist spring in the subhumid region, and an excess of rain-fall in eastern and southern Texas. A long, cold winter generally means a rather dry spring in the subhumid, and a moderately moist spring in the humid region. Nearly all of the moisture precipitated in Texas is derived from the Gulf of Mexico, over which the rain clouds are formed and then drifted northward and westward as far perhaps as northern Kansas or Nebraska and eastern Colorado. The Staked Plain, the Pan Handle, where the altitude is over 3,000 feet, and the mountain ranges of El Paso County and New Mexico may be properly called the weather breeders of the State. As spring opens in Texas generally in February the low-lying lands of the eastern and southern parts of the State warm up first under the genial influence of the sun. The prevailing winds are then from the south, spread*ing out fan-like* as they proceed northward. They are warm, and carry much moist-

ure, which is dissipated in Kansas, Nebraska, and northward; as the cooler temperature of these States is encountered, at intervals of about two weeks during each spring, a norther will sweep southward, pushing before it the moist clouds from the Gulf. The vapors are suddenly condensed, causing a snow-fall in Kansas, and a day or two later, heavy rains in eastern and western Texas. The blizzard will continue on to the Gulf, and a few days later return in a greatly demoralized condition. The warm south wind is pushing it northward, and the line of contact between the opposing winds is the source of another rain-fall; a wet norther generally brings with it about a week's rain. For about two weeks following the norther there will be mild, balmy spring weather, and then another norther may be expected, bringing with it another rain or cold, windy, and disagreeable weather. During February and half of March the humid region gets nearly all the rain that falls. In March and April the subhumid region begins to share in the rain-fall, and by the middle of April it has warmed up sufficiently to attract a goodly portion of the rain clouds. The winds have shifted more to the westward, and carry much more moisture there than they did the month before. Vegetation in eastern and southern Texas has generally obtained a fair start in March, and corn is well up. The subhumid region shows signs of awakening about a month later than the humid region. Between April and May the Staked Plain, or semi-arid region—altitude 2,000 to 3,000 feet—has warmed up, and partakes copiously of its semi-monthly potations of rain-water, and about the end of May wears its Sunday clothes, the whole plain being a carpet of flowers, consisting of hundreds of varieties, many of surpassing beauty. Between June and July the moist Gulf winds have reached the mountain ranges of El Paso County and New Mexico, and the heavy rains of the arid part of Texas may then be expected. In the interval between February and the end of June the greater portion of the precipitation is dependent upon the northers, which seem to come between the 5th and 9th and the 17th and 21st days of each month, bringing with them a sufficient lowering of the temperature to cause precipitation. Between June and September a change of temperature is also noticeable about the same time in each month, but the change is not sufficiently pronounced to cause rain-fall. To ascertain what relation there is between these constantly recurring northers and the changes of the moon would be an interesting study. Between June and September, much of the precipitation is subject to purely local causes, as in midsummer the thermometer ranges equally high in all parts of the State, though there is a material difference in the humidity of the air. As far as personal comfort goes, a temperature of 100° Fahrenheit at an altitude of 2,000 feet is far more agreeable than a temperature of 80° at an altitude of 500 feet.

During midsummer rainbearing clouds are nearly always in sight in the subhumid, semiarid, and arid regions, and anything that will cause a disturbance of the equilibrium of the temperature will bring about a rainfall. It has been frequently observed that the evaporation from a dry water-course, or a field in cultivation will chill a passing cloud sufficiently to cause a heavy local shower. A sandy tract of land absorbing more heat than the surrounding densely grassed lands will frequently cause local winds to rise, which coming in contact with a passing cloud will cool it by evaporation of part of the moisture of the cloud itself, and cause a general disturbance of the equilibrium of temperature and bring about a heavy rainfall, extending sometimes over several hundred miles. A prairie fire extending over several miles of country has been observed to have a similar effect. In the mountain region the average annual rainfall on the level mesa lands does not exceed 12 inches, but on the mountains it rains often and the showers are nearly always heavy, one single rain sometimes equaling 12 to 18 inches. It appears that owing to their great altitude the mountains are always cooler than the clouds, and whenever they come in contact the clouds are sure to be robbed of nearly all their moisture. It is a well known fact that all the mountain ranges of El Paso have their springs and their verdure on the eastern slope, and none worth mentioning on the western side. It seems also, that during the summer months the gulf winds are deflected northeastwardly by the mountain ranges of New Mexico, as it is claimed by residents of western Kansas and the northeastern Pan Handle of Texas, that their heaviest summer rains nearly always come from the southwest. From August to December the rainfall gradually decreases in western Texas. The highest elevations west of the Pecos River lose their heat first. Their ability to attract the moist winds from the gulf decreases and the rains become fewer and lighter, and after August very little rain is expected. In the semi-arid region heavy fall rains are usually expected up to the middle or end of November, subject to the semi-monthly northers. In the subhumid region heavy rains will generally come until December 25th. In January and February very little rain is expected. The routine work of the norther is occasionally disturbed by a general rain covering all the Gulf States, but these as a rule are too irregular to cut any figure in the general weather system of the State. About the 1st of January winter sets in in earnest. Two to 6 inches of snow in northern Texas, 2 to 4 inches occasionally on the Staked Plain, heavy snows on the mountain sides, and hardly any on the mesas in

El Paso County; heavy rains in eastern and southern Texas during the prevalence of a norther usually constitute a Texas winter. The temperature rarely falls below zero, though it sometimes reaches 4 to 6 degrees below. An ordinary norther in mid-winter generally ranges a few degrees above or below freezing point, and seldom lasts longer than a week.

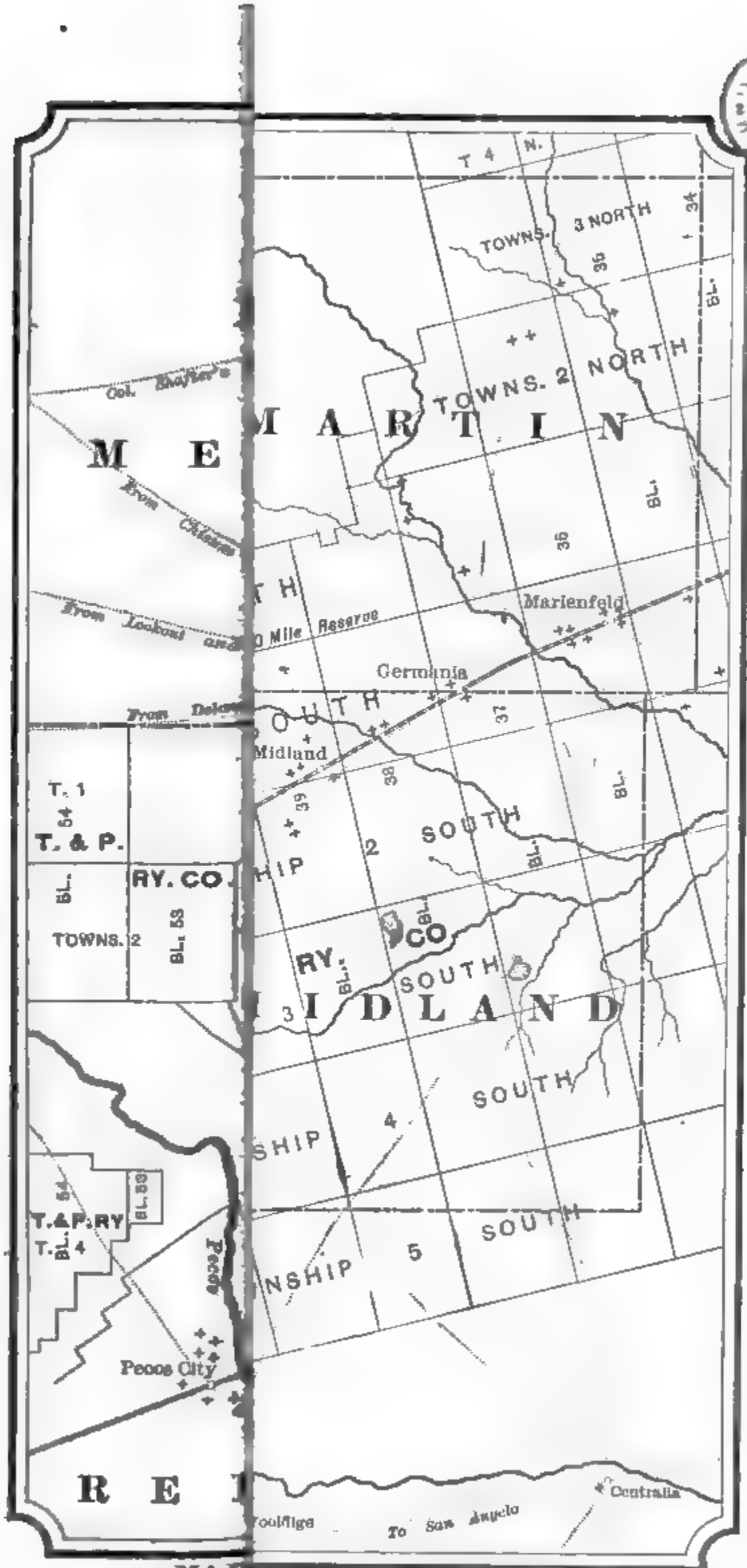
TOPOGRAPHY OF THE SUB-HUMID REGION.

A profile of the Texas and Pacific Railway will show the following changes in altitude, proceeding westward from Brazos River: Brazos crossing, 750 feet, but at Lamber, 30 miles east, nearly 1,200 feet; at Gordon, 875 feet; at Strawn, 900 feet; at Ranger, 1,425 feet; at Eastland, 1,500 feet; at Baird, 1,700 feet; at Clyde, 2,025 feet; at Abilene, 1,700 feet; at Merkel, 1,875 feet; at Trent, 1,920 feet; at Sweetwater, 2,175 feet; at Loraine, 2,297 feet, and at Colorado River crossing of the Texas and Pacific Railway, 2,075 feet. The surface of the northern part of the subhumid region in general presents large expanses of gently undulating prairies, broken in a few places by stretches of rolling and hilly land, and along the water-courses by small areas of rough and broken land; about four-fifths of all the land is suitable for cultivation. The soil on the uplands or table-lands is generally red or chocolate colored loam, of great fertility. The river and creek valleys have dark and black loams, generally heavier than the uplands. Along Red and Brazos rivers the soils are usually a bright red in color, but quite as fertile as the best black lands. On the uplands are numerous mesquite flats, or nearly level tracts, which generally have heavier and darker sandy loams than the adjacent tracts. On the ridges or local divides, between the smaller water-courses, are narrow strips of red or grayish sand, commonly known as shinneries.

The native vegetation of the black or dark valley lands, or of the nearly level mesquite flats, is generally the short, curly mesquite grass. The more mellow red and chocolate lands are usually covered with gramma and other varieties of grasses, while the sandy lands carry from fifty to seventy-five different varieties of native grasses, as well as an unlimited number of flowering weeds, mesquite, shrubs, chapparell, uno de gato, post oak, live oak, shin oak and sedge grass 6 to 7 feet high, grow on these lands in the greatest profusion. The soils, considered from an agricultural point of view, are very well adapted to general farming, and ordinarily produce, without resort to irrigation, the following crops per acre: wheat, from 20 to 30 bushels, frequently 40 bushels, weighing from 61 to 68 pounds to the measured bushel. In isolated cases 45 and 50 bushels bave been made. Corn yields from 20 to 45 bushels, and if the rain comes "just right" 60 and 70 bushels. Oats run from 50 to 65 bushels per acre, but 100 to 110 bushels are frequently made by a few individuals. Cotton is grown as far west as the Colorado River, in Mitchell County, and quantity per acre and quality are considered equal to that of any other part of Texas; a crop of some kind has been made in every year since 1882, excepting the droughty years of 1886 and part of 1887. The unusual duration and exceptional severity of this drought is perhaps best illustrated in the fact that in parts of Eastland and Callahan counties thousands of forest trees, which had reached an age of thirty to forty years, withered and died, showing that there had been no such drought in their lifetime, or within thirty to forty years before. As to the drought-resisting qualities of the various soils, it can be said that the black river-bottom soils have the advantage of natural subirrigation, and will resist a short spell of dry weather easily. The black or dark mesquite flats produce equally as well as the river bottoms, but during a severe drought will suffer considerable, often reducing the yield to one-fourth or one-half crop. The mellow and porous red lands of the table lands, while probably not so rich as the black bottom lands, will in time of dry weather make a better and larger crop than any of the lands above mentioned. The ridge soils, are sandy "shinneries," retain moisture to a remarkable degree, and while apparently thin and poor in quality will withstand a drought almost indefinitely. No fruit trees or vines planted on these lands have succumbed to the drought of 1886-'87, and all that was harvested during this period was grown on shin oak land. The timber of the subhumid region is mainly found in the "upper cross timbers," a belt of oak forest extending from Red River southward for a distance of 100 miles or more, and varying in width from 5 to 50 miles. This forest consists in the main of live oak, black jack, post oak, red oak, shin oak, and a few other varieties. The Texas and Pacific Railway passes through the upper cross timbers between Weatherford and Baird. Small local areas of timber of other kinds are found in nearly all counties, and consist of pecan, elm, hackberry, cottonwood, cedar, chittim, wild china, etc. East of Clyde Station there is timber in abundance for all uses of the farm. West of this point there is enough timber for fuel, but the country is essentially open prairie, except in the river and creek bottoms.

WATER SUPPLY AND IRRIGATION.

To a direct question as to whether or not a farmer can hold his own in the subhumid region of Texas, without resorting to irrigation, I should certainly reply in the affirmative. Taking one year with another, I think it perfectly safe to make the



MA[illegible]N WELLS THEREON.

Report on Irrigation.

assertion, that notwithstanding the fact that the sub-humid region has passed through a most severe period of drought, the aggregate losses by drought of each acre under cultivation, compared with another acre located in Eastern Texas, will amount in dollars and cents to less in the subhumid region, during a period of seven years, than do the losses in Eastern and Southern Texas by reason of excessive rainfall. In the subhumid region there have been two total failures and an occasional partial failure of crops. In Eastern and Southern Texas there have been partial failures nearly every year, and it is a rare occurrence that a full crop of all that has been planted is secured. A total failure of all crops in the humid region is not known, but a perfect crop of corn, cotton, wheat, oats, and fruits, from the same farm in the same year is a very rare occurrence though the subhumid region has produced such several years in succession. The question of farm drainage by ditching and tiling in Eastern and Southern Texas is becoming more and more pressing each year. If it rains too much and the crop is in danger of spoiling, it is too wet to cut a ditch, and when it is dry weather, the East Texas farmer doesn't need a drainage ditch. The farmer in the subhumid region is slowly availing himself of the natural facilities rendered for irrigation, and is gradually realizing the fact that a liberal water supply applied to a crop at the right time will bring a cash dividend much quicker than a dozen protracted prayer meetings. One or two irrigations of 2 or 3 inches each on the level, will make a full crop every year, and for some years in succession no irrigation will be needed. There is in all counties a critical moment, when the precipitation or absence of rain will decide the fate of the crop. No portion of the United States is better provided with the facilities for overcoming this critical moment by an occasional irrigation than is the subhumid region of Texas.

Small grain generally will pull through without irrigation, and cotton likewise. Corn could be doubled in yield if irrigated occasionally. Fruits and vegetables could be grown with absolute certainty, but in addition to these, hops and many other high-priced commodities could be grown to perfection. Instead of growing one garden crop, the subhumid farmer should grow three. The storage capacity of the subhumid region is enormous, and the rain-fall necessary to utilize this capacity is ample. Very few places exist in which there is not sufficient water for 5 up to 160 acres under irrigation. The Red River, Brazos, Colorado, and Conchos, and their numerous affluents afford water in abundance all year round. The headwaters of these affluents carry water part of the year, and could be easily dammed and made available for the whole year. In the more hilly portions are many hundred depressions that catch the drainage of a large area, and could be made to store immense quantities. Springs are found in nearly all counties, and are becoming more numerous since the land is placed in cultivation. Water in ordinary dug or bored wells is found in almost all places where sought for, and by the use of wind-mills could be raised to the surface and be used for irrigation. The drought of 1886–'87 brought to light a few points of interest bearing on the underground water supply. In 1886 the drought extended over the entire subhumid region. The Black Wax belt of Texas, extending from Weatherford to Mineola, and from Red River to the latitude of Austin, received sufficient rain-fall to mature crops. East of the Black Waxy region, both in Louisiana and in southern Texas, as far as the Gulf coast, the weather was exceptionally dry. Of all the wells dug or bored between the Pecos and Sabine rivers, none were affected by the drought except a considerable number of wells in Shackelford, Eastland, and Callahan Counties, which temporarily lost their water. The wells in the counties east and west did not show any diminution of their supply during the drought. In August and September heavy rains began to fall in southern and eastern Texas, while none fell in the subhumid region, which is from 500 to 1,000 feet higher. The dry wells in Shackelford, Eastland, and Callahan Counties, within a few days were again supplied with water, though no rain had fallen in the neighborhood or at any point of greater altitude within 600 miles.

The filling of the wells was at the time a subject of remark, and was not explained. The only explanation possible is, that the waters from the mountains of New Mexico and Colorado find their way to the Gulf of Mexico through underground channels, and that they maintained an unobstructed flow southeastward during the entire period of drought. Wherever the strata lay close enough to the surface to be dug or bored into, they furnished an unlimited supply of water. In places where the channels lay deeper the underground waters were not reached, as in the counties mentioned, but the wells were dependent on the local rain-fall. In a wet year in eastern and southern Texas, the underground channels become clogged through the pressure of the water above them, and as the water lies between impervious strata and can not find a ready outlet, it causes the backwater to rise a thousand feet or more. The wells in the counties mentioned were therefore filled by the water coming from New Mexico and Colorado, which could not find an unobstructed flow to the Gulf of Mexico. If there had been no drought in southern and eastern Texas, as well as in the subhumid region, the supply in the wells of Callahan, Shackelford, and Eastland Counties would have remained normal *whether it* rained or not in western Texas. As a

further proof that there exists an underground system of rivers extending from the mountains of El Paso County, New Mexico, and Colorado to the Gulf, it can be said that a considerable number of these underground streams have been discovered in various portions of Texas; but perhaps the best evidence of an underground connection between the mountains and the Gulf, is shown in the famous "Breathing Well," at Eagle Flat in El Paso County, Tex. This well is distant about 550 miles from the nearest point on the Gulf coast. Its altitude above sea-level is 4,500 feet. A boring of 300 or 400 feet was made in the hope of finding water, but instead, an underground cavern was discovered, and the work of boring discontinued in consequence. With the removal of the boring apparatus it was discovered that for a number of hours a current of air would be forced out of the bore-hole, and that later in the day there was great suction of air into the cavern. This process repeats itself every day. The only way to account for the "breathing" of the well is that the lower end of this cavern is alternately filled with water, and again emptied by the tides of the Gulf, over 500 miles away. An examination into the mysteries of the underground rivers, channels, and deposits of water, is of importance, not only from a commercial and agricultural, but also from a scientific point of view, and merits much more attention than is now given the subject. The artesian waters lie deep in the subhumid region, and but few wells of limited capacity have been bored. It is thought, though, that artesian water can be had by borings of proper depth. The upland prairie farmer will have to depend in a great measure on his well and wind-mill, and will generally find enough water for his purposes. The writer understands perfectly well that a 160-acre farm can not be irrigated from a common barn-yard well, and knows also that not one in five hundred farmers is financially able to bore or dig enough wells and erect enough wind-mills to irrigate such an acreage. There is nothing in the way, however, to prevent the subhumid farmer from successfully irrigating 5, 10, or 20 acres, and to plant on this irrigated land such crops as will bring the highest possible market prices. If he will not grow for the market, he can to almost absolute certainty raise all the food products needed for home consumption. In a droughty year, like 1886–'87, he may not make any money, but will always have enough to maintain his household, and thus avoid becoming an object of charity. He can still raise wheat, corn, cotton, hay, and forage generally on his dry land, but his irrigated patch will secure him a money return of five times the value per acre, than will his dry land under cultivation. Having neither topographical maps of the respective subhumid counties, or detailed information as to the exact location of water supply, or storage sites at hand, this report is more general in its character than it should be, but it is hoped that some information may be found therein that may be of use.

Adjourned.

ON TRAIN FROM MIDLAND, TEX.,
September 9, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF B. F. WILLIAMS, OF FORT WORTH.

The CHAIRMAN. How is agriculture prosecuted in this section of the country?

Mr. WILLIAMS. In various ways. There has been a good deal of experiment here with farming in different ways, but they are trying mostly to demonstrate it here by irrigation; but it has been very poorly prosecuted, take it as you may.

The CHAIRMAN. Can you raise crops here without irrigation?

Mr. WILLIAMS. You can when you have any season for it.

The CHAIRMAN. How often do the seasons prove favorable?

Mr. WILLIAMS. Once in four years.

The CHAIRMAN. As often as that?

Mr. WILLIAMS. Yes, I think so.

The CHAIRMAN. What do the people do in the meantime?

Mr. WILLIAMS. Some of them try it—keep making experiments, but do not do anything.

The CHAIRMAN. What success have you had by means of irrigation?

Mr. WILLIAMS. From my own observation there has been very little success. So far as experiments have been made they have been satisfactory.

The CHAIRMAN. How many wells are in this vicinity?

Mr. WILLIAMS. For irrigation purposes?

The CHAIRMAN. Yes; for irrigating gardens or anything of that kind.

Mr. WILLIAMS. There are three here that I know of.

The CHAIRMAN. We have seen more than that.

Mr. WILLIAMS. They are not for irrigation. I only speak of what I have seen—the results of my own observation.

The CHAIRMAN. You have seen three?

Mr. WILLIAMS. Yes.

The CHAIRMAN. What size wells were they?

Mr. WILLIAMS. Six inches in diameter.

The CHAIRMAN. Do you know how deep?

Mr. WILLIAMS. No, I can not tell you the exact depth at Midland.

Mr. GEORGE E. BRIGGS. The depth of the water is 70 feet.

The CHAIRMAN. With the three wells that you have observed here for irrigation purposes, what do you raise?

Mr. WILLIAMS. Well, fruits, vegetables, and different kinds of crops by means of irrigation.

The CHAIRMAN. How do the fruit trees get along?

Mr. WILLIAMS. They do exceedingly well. I have noticed more trees this year that had as much as 5 feet of growth on them than heretofore. They were peach trees.

The CHAIRMAN. Did they get that much growth in one year?

Mr. WILLIAMS. Yes; I can show you cottonwood irrigated a very little, with 10 feet of growth.

STATEMENT OF GEORGE E. BRIGGS, OF COLORADO.

The CHAIRMAN. You have lived at Midland?

Mr. BRIGGS. Yes.

The CHAIRMAN. Are you acquainted with the wells run by windmills in Midland?

Mr. BRIGGS. Yes.

The CHAIRMAN. Will you state about what amount of water is thrown out by the different wells, and the size of the windmills?

Mr. BRIGGS. As a rule they use 12-foot mills; that is, for stock purposes and for domestic use. They do not irrigate. I irrigated 2½ acres and subirrigated the trees that I planted out a year ago this April. This season they bore fruit. I had one tank that held about 46 gallons of water. I had it shut off half the time, and more too, I judge.

The CHAIRMAN. If you had saved all the water during the year with a suitable tank how much land could you have cultivated with a 12-foot mill?

Mr. BRIGGS. I think a man could irrigate by subirrigation 10 acres. That is of course quite different from surface irrigation, that is by saving all the water that a 12-foot mill would pump.

The CHAIRMAN. What do you say of this locality for fruit?

Mr. BRIGGS. The finest I ever saw for peaches, plums, and lemons

The CHAIRMAN. How are the *pears*?

Mr. BRIGGS. The trees that I have seen at Colorado have no fruit, but they grow finely. In Colorado they grow abundantly.

Senator REAGAN. How with regard to grapes?

Mr. BRIGGS. They do remarkably well. The California and European grapes do as well as they do in California. So people tell me.

Senator REAGAN. Have any of them been cultivated long enough to produce fruit?

Mr. BRIGGS. Yes, fine. I have some put out a year ago last March, and they bore a quantity of grapes.

Senator REAGAN. What kind?

Mr. BRIGGS. The Muscat and Black Prince. I do not know the varieties. I bored a well on the Staked Plain.

Senator REAGAN. What material did you go through?

Mr. BRIGGS. Lime rock, principally.

Senator REAGAN. At what depth did you strike lime rock?

Mr. BRIGGS. It varies from 15 to 30 feet. I have one well 30 feet.

Senator REAGAN. How thick is the lime strata?

Mr. BRIGGS. Well, it varies. I can not tell you that; I do not know how thick it is.

Senator REAGAN. But you go through it?

Mr. BRIGGS. Yes, go through it.

Senator REAGAN. Before you get your well?

Mr. BRIGGS. Yes, it is from 40 to 70 feet deep.

Senator REAGAN. And the lime rock is 30 to 50 feet?

Mr. BRIGGS. Yes; and there is some red clay. I think the rock, as a rule, is not over 10 or 12 feet, and then they strike another layer.

The CHAIRMAN. In what do you find the water?

Mr. BRIGGS. The best water is found in this white gravel. If you go to that depth you will strike it at 68 feet.

The CHAIRMAN. After passing through lime rock you strike gravel?

Mr. BRIGGS. Yes.

The CHAIRMAN. White gravel beneath the lime rock furnishes the water.

Mr. BRIGGS. Yes; and you can not exhaust it. I have let my well run for ten days at a time and never exhausted the water.

The CHAIRMAN. Does the water rise in a pipe?

Mr. BRIGGS. About 30 feet—stands that way. The lime rock is very shaly and porous. It will absorb an immense amount of water. It would rise much higher if that were a solid mass.

Adjourned.

TOYAH, TEX., *September* 9, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF H. H. CLOUD, OF EDDY, N. MEX.

The CHAIRMAN. What is your occupation?

Mr. CLOUD. Civil engineer.

The CHAIRMAN. On what works are you now engaged?

Mr. CLOUD. The Pecos Irrigation and Investment Company's canal.

The CHAIRMAN. Where is that canal?

Mr. CLOUD. One is located about 5 miles from Roswell, taken out in *Lincoln County*, N. Mex. It is taken from the Pecos and Hondo Rivers.

The length of it will be 37 miles to 40 miles, when completed, and will cover about 100,000 acres of land. The lower canal is in the same county, but it will also be in Eddy County, N. Mex. It is projected to be 50 miles in length.

The CHAIRMAN. Will that get into Texas?

Mr. CLOUD. No, it will cover about, as contemplated now, 100,000 acres of land.

The CHAIRMAN. Will that exhaust the capacity of the river?

Mr. CLOUD. It will not.

The CHAIRMAN. Is there a large amount of water running in the river?

Mr. CLOUD. There is an extraordinary amount of water.

The CHAIRMAN. In flood times how is it?

Mr. CLOUD. Very large.

The CHAIRMAN. Has it been gauged?

Mr. CLOUD. I think it has been in flood time. Mr. Nettleton has the figures on that. He is Mr. Powell's assistant, on the irrigation survey.

The CHAIRMAN. He has the gauging of the river?

Mr. CLOUD. Yes.

The CHAIRMAN. How much land is there on the Pecos that might be irrigated, if there were water enough?

Mr. CLOUD. I can not say; but it is practically inexhaustible.

The CHAIRMAN. Practically unlimited?

Mr. CLOUD. Yes.

The CHAIRMAN. What are the opportunities for storing the waters of the river and increasing the volume?

Mr. CLOUD. They are very excellent. I know where water reservoirs could be constructed, where 5,000,000 cubic feet of water could be stored.

The CHAIRMAN. What is the character of the country for reservoirs? Explain a little more particularly.

Mr. CLOUD. Immediately above our lower canal there are places where the bluffs come in toward the river, and by damming at those points we can make extensive reservoirs. We have not had the exact surveys except on one, and if we make our dam at that point it will have a capacity of 500,000,000 cubic feet.

The CHAIRMAN. What is the character of the land on the Pecos, in New Mexico and Texas?

Mr. CLOUD. Well, it is a lime soil. I have been here but four months at the canal itself.

The CHAIRMAN. Have you any knowledge of the fertility of the soil?

Mr. CLOUD. Mr. Shields, at Las Cruces, has made experiments, and so has Mr. Eddy, and I know they grow large crops at Rosswell. They have very fine orchards, and they yield immensely.

The CHAIRMAN. And generally it is good land?

Mr. CLOUD. Yes; and will produce all sorts of crops. They say it is very fine for fruit and grapes and things like that.

The CHAIRMAN. Do wheat and corn grow generally?

Mr. CLOUD. Yes; corn, potatoes, and crops of that kind.

The CHAIRMAN. Is there anything further that you could state?

Mr. CLOUD. It seems to me that the opportunities here are exceedingly great for investments of this kind.

The CHAIRMAN. There are opportunities for reclaiming the land?

Mr. CLOUD. Yes. At Pecos you will find another ditch under construction. The engineer of that is Mr. Wood. He is not here now.

Adjourned.

FORT WORTH, TEX.,
September 11, 1889.

The committee met pursuant to call of the chairman.

Present, Messrs. Stewart (chairman) and Reagan; also Director Powell.

STATEMENT OF W. S. MARSHALL, OF FORT WORTH.

The CHAIRMAN. Are you familiar with western Texas, the water supply, and the chances for irrigation in that region?

Mr. MARSHALL. Yes, I am somewhat.

The CHAIRMAN. Make your statement in your own way.

Mr. MARSHALL. I have worked in western Texas putting in wells, erecting windmills, in stock raising, and developing the water supply there for four years. I can give you a map of the country in which we have done most of our work. This country here and in Pecos County, Reeves County, El Paso County, Crockett County, Tom Green, and all of Old Tom Green, including the six or seven new counties, we have something like six hundred wells. I traveled over this country, 9,000 miles, in my buggy and investigated it personally.

The CHAIRMAN. Describe the country.

Mr. MARSHALL. Starting at the south here through Pecos County and Tom Green an abundant supply of water is to be had. We will take at Dryden, on the Southern Pacific road—the well is 1,800 feet, and the water after they struck it came within 600 feet of the surface. We built some wells north of Dryden on the Pecos, one of them 650 feet. That was connected with three more from 300 to 500 feet. We have got to go a great depth for water in that county.

The CHAIRMAN. Is it good water and plenty of it?

Mr. MARSHALL. Yes, at 1,800 feet. Then north of there, at Pecos City, we got flowing water. Every well we put down—the deepest was 275 and the shallowest was 235 feet.

The CHAIRMAN. What did you go through?

Mr. MARSHALL. At Pecos we struck no hard rock at all. There are gravel veins, thick sand, and hard clay. Then there is an alkali, we call it; but it is a sort of decomposed lime. I thought it was alkali, but the State geologist gives no record in his report. There is no rock at Pecos City, but there is rock in the southern part of Pecos County.

The CHAIRMAN. There was a radical change of formation then in these shallow wells.

Mr. MARSHALL. Where we got the flows?

The CHAIRMAN. Yes.

Mr. MARSHALL. I would not call it a radical change. We struck a very hard substance; it was not a rock; it was hard pan. It was what I call a clay hard pan. That was only 18 inches thick, and as soon as we broke through that the water commenced to flow.

The CHAIRMAN. That is what held the water down?

Mr. MARSHALL. It is a 3-inch hole, and it flows 350 gallons a minute. Those wells are very strong. Now, working north, take the center of the Staked Plain as a sample, and there is a vast change in the country; it is what gives the country the name of Staked Plain. But north of here the cactus and Spanish bayonet and all that sort of vegetation disappears, and you come on to a perfect type of prairie, such as you *find in Nebraska* and Iowa. The mesquite and gramma grasses grow *there, and the lay* of the country is exactly the same and the forma-

tion is the same, as I found putting in wells in Iowa. There we strike water in abundance. In Hockley County, for instance, we never made a failure in finding the water, and I know there are fifty wells we put wind-mills on.

The CHAIRMAN. At what depth?

Mr. MARSHALL. One hundred seventy-five feet; the shallowest is 35 feet. The average will be 100. None of them are as deep as 200 feet. The water very seldom rises there except in the northwest corner, where there is a valley and where there are surface veins at 100 feet, and a flow of 200 gallons a minute. Those were the only two flowing wells. In Hale County the wells run shallower, not over an average of 50 feet in the whole county. In Crosby County they run 100 feet, and in the west part of Lubbock, you go 300 feet to get good water. But all through this country there is an abundance of good water when you get down to it, and that is within 400 feet.

Senator REAGAN. Do you know of a flowing well north of this point?

Mr. MARSHALL. I do not know of any.

Senator REAGAN. Is there not a flowing well north of Washburn?

Mr. MARSHALL. No; I do not know.

Senator REAGAN. Where is it?

Mr. MARSHALL. I do not know of a flowing well on the railroad.

Senator REAGAN. The newspapers have it reported that there is one.

Mr. MARSHALL. At Washburn we have fitted up a pump for the railroad. I am not sure whether I am right about Washburn. I do not think there is a well on the Denver and Fort Worth road in Texas, except it may be in Fort Worth.

The CHAIRMAN. What have you to say as to water tanks, etc.

Mr. MARSHALL. The drainage of that country is in basins or surface lakes. There is no place where the water will flow across and run to important streams, but it runs in basins. It is like a saucer. The drainage water that falls in the different seasons of the year goes into those basins, and either evaporates or goes away with the underground drainage. The rain-fall there is a great deal more than in the center and lower ground.

Senator REAGAN. What is the topography of that country through there?

Mr. MARSHALL. A rolling prairie country.

Senator REAGAN. No mountains?

Mr. MARSHALL. No. [Indicating on the map.] There are very few passes. You can not drive upon the plains in some places. It is a wall right up and down, and at other places it is breaking away—the earth, rock, and so forth. When you get on one of these plains you have the horizon all around about. It is a high country. To the west you just see a hill 6 or 8 miles ahead of you; but when you get there there is another one. You are going up all the time.

Senator REAGAN. Is there any irrigation in that country?

Mr. MARSHALL. No. There is some at Toyah. I do not know what they have done there.

Senator REAGAN. Is there any here?

Mr. MARSHALL. By windmill at Midland. Also at Odessa, and also at Mansfield. That is in Hamilton County.

Senator REAGAN. Is there any in Tom Green County?

Mr. MARSHALL. There is some irrigation near San Angelo, Tom Green County. That is from the streams. There are no streams here from which there could be any irrigation, unless they were dammed and the water saved at the time *the rains* come.

The CHAIRMAN. What are the chances for that? Explain that.

Mr. MARSHALL. In the headwaters of all these streams there are plenty of draws to be dammed across and make large basins. I have come across the river perfectly dry, and then there would come a big storm and for four or five hours there would be plenty of water; but it would be dry again in twenty-four hours.

The CHAIRMAN. Could you find places where you could hold it?

Mr. MARSHALL. I think there could be, because the subsoil is clay on the top and rock underneath. Generally the river is all run down to the rock and the top soil is clay.

The CHAIRMAN. And you could find places where ponds of water could be had?

Mr. MARSHALL. We would have no trouble for ponds of water for our windmills—pumping into the cañon and having it full of water in a short time. There would be no trouble in making a dam and having it impound the water. I have seen a good deal along the Colorado in Mitchell County. There is a pond that I have never seen dry. Fish put in there six years ago are there yet.

The CHAIRMAN. The country north of that is similar?

Mr. MARSHALL. Yes. There is water enough falls in that country to be saved. There is a little mistake in the distribution of it, the time they send it out. There is a full description and plat of it. [Producing paper.] We got this out to distribute to the stockmen.

The CHAIRMAN. I wish to ask you about the expense of tar and pitch. It seems to me that, as in California, there would be a vast amount of bitumen here and a great quantity of bituminous rock.

Mr. MARSHALL. There is bitumen in this county. Take also Navarro County. All through that country we find that water must be conducted over sandy, loose ground, where the seepage is very destructive.

The CHAIRMAN. Have you given any attention to the cost of these things?

Mr. MARSHALL. Yes; that can be made and kept up at very much less expense than would be the case with plank or cement. In our tank works I have used all three—cement, plank, and coal-tar. I find coal-tar, while in some instances it costs a little more for a small tank than for wooden tank, yet when you get up to 250,000 gallons the cost is not one-tenth. In fluming I should think the plank would be as much to make it good. It would cost about $4 a hundred square feet. That woul be there equal to lumber at $40 a thousand. But when it is there it is for all time.

The CHAIRMAN. That depends somewhat upon the freight.

Mr. MARSHALL. It would not cost that here. It costs freight from here out to where we have used it west 33 and 38 cents a hundred.

The CHAIRMAN. What would it cost here?

Mr. MARSHALL. I could put it down here inside of $3 a square.

The CHAIRMAN. That would be less than 3 cents a square foot.

Mr. MARSHALL. Yes; if it runs out of water and stands in the sun it does not open the cracks; if it runs out of water and freezes it does not open the cracks. It remains perfectly tight without any repairs. We find it is the case with that where it is not the case with cement and not with plank. Once put on there it costs practically nothing to keep it up.

The CHAIRMAN. In what portion do you mix it?

Mr. MARSHALL. We just take coal-tar pitch. If we can not get that we take the coal-tar and boil it down and make pitch. When it gets stringy, and to ascertain that you do as you would in the case of making

molases candy, put a stick in it to see if it strings out. We generally put it on hot, with two coats; the first coat being hot is just like water, and it will soak into the sand and make a quarter and a half inch coating, according to the condition your bank is in. It becomes a kind of amalgamation of sand and pitch. Then you put your sand on the top to keep it from running. We thought it better not to put on any sand at all, but just a thin coating of pitch, a double coat. When you have it on from a half to three-quarters of an inch thick, you can walk on it, walk all over it and being a little careful not to dig your heels into it. Even in the hottest days it will bend under your feet and not break. We tell everybody that the reservoir down there cost $1,800. That is half what it would have cost to build it of stone. The actual cost was $1,150 to $1,200.

STATEMENT OF E. T. DUMBLE, OF AUSTIN.

The CHAIRMAN. What is your occupation?

Mr. DUMBLE. I am the State geologist.

The CHAIRMAN. Are you familiar with the topography, the water supply, and the means of irrigation in western Texas?

Mr. DUMBLE. As well as it is possible to be in the short time that we have been at work.

The CHAIRMAN. Make any statement in regard to it that you think would be interesting to the committee.

Mr. DUMBLE. Do you wish to know what the chances are for irrigation in western Texas?

The CHAIRMAN. Yes; state what the chances are for irrigation in that section.

Mr. DUMBLE. Well, you have examined the Rio Grande, and so you know all about that. Have you information with regard to this country through here, that is, below the railroad on which you came in?

The CHAIRMAN. No. State anything that you know of this side of the Rio Grande—the waters that do not flow into the Rio Grande. We wish to know about them.

Mr. DUMBLE. There are no running waters of any consequence. But these flats are all susceptible of irrigation.

The CHAIRMAN. To what flats do you refer?

Mr. DUMBLE. The country is a series of flats or plains interrupted by mountain ranges, and in those ranges there are places in which dams could be made that would hold water sufficient for irrigating a large amount of land that lies in the flats. The rain-fall, as nearly as we have gotten at it, is from 15 to 20 inches yearly throughout that region. One section, in Quitman Mountain, the one we have examined most closely, a dam about 200 yards long will hold the drainage of some 45 square miles in those mountains. That opens out on this flat below here, a large plain. That is true of a great many other mountain ranges through there. At Fort Davis there is already considerable irrigation from the waters of the Olympia Cañon on Olympia Creek.

The CHAIRMAN. Do they store the water there, or do they take the natural flow?

Mr. DUMBLE. The natural flow. The city of El Paso and presidio—there are many places where the water could be stored and used for irrigation and stock-raising or for mining purposes.

The CHAIRMAN. It would not be very expensive, would it?

Mr. DUMBLE. No, not very expensive; because the mountains are tolerably steep, and material is always at hand to build the dam.

The CHAIRMAN. Do the streams discharge in narrow gorges?

Mr. DUMBLE. Yes.

The CHAIRMAN. Can there be some irrigation from wells?

Mr. DUMBLE. I do not think so. The water so far as yet found lies too deep, and it would be too expensive to pump it. The railroad companies have gone down 700, 800, and 1,000 feet all along the line without getting water. That is between the Pecos and the Rio Grande.

The CHAIRMAN. Does it extend up north?

Mr. DUMBLE. The plains come in here—about Drouro Station on Texas and Pacific [indicating on the map]. It takes in the mesas.

The CHAIRMAN. Have you been up the Pecos to its source?

Mr. DUMBLE. No; I have not.

The CHAIRMAN. Take it farther north, in the Pan Handle, have you been there?

Mr. DUMBLE. No.

The CHAIRMAN. Can they irrigate with wells?

Mr. DUMBLE. Yes.

The CHAIRMAN. They have equal facilities for storage reservoirs, have they not?

Mr. DUMBLE. They have on the east side of the Staked Plain, where those cañons make in and streams begin there. The whole body of that country is red clay, and they can build dams there for reservoirs very well. There in Tom Green County, on the Conchos, they are damming those creeks, and will have an abundance of supply of water for irrigation. They are increasing that all the time, and they are increasing their water supply.

The CHAIRMAN. From your observation what is your opinion as to the extent of irrigation that may be generally, not in detail, practiced in western Texas, where rain-fall is insufficient?

Mr. DUMBLE. They can irrigate nearly every part of it. There are some flats or plains in between the mountains where the land to a great extent could be reached by it.

The CHAIRMAN. What would be the productive capacity of that country when irrigated?

Mr. DUMBLE. It would be very great. The soil is very fine. It is old lake bottoms.

The CHAIRMAN. How is the climate for products?

Mr. DUMBLE. That I do not know; I could not say. The thermometer gets very high, but it is a dry climate.

The CHAIRMAN. I mean in reference to the production of crops.

Mr. DUMBLE. They grow anything that will grow around El Paso, and in that country, wheat and all kinds of fruits; corn, cotton, and anything of that kind which is suitable to this lower country.

Senator REAGAN. Is you bureau collecting statistics about irrigation?

Mr. DUMBLE. Yes; all we can. For instance, I am having the border of the Staked Plain mapped, with instructions so that they may know the places where dams can be built, and in Tom Green County I have a map of that irrigation district, and I am having a map of the suitable places in El Paso County where dams can be made.

Senator REAGAN. On the western tributaries of the Colorado there is some partial need of irrigation. What do you say about the streams down there?

Mr. DUMBLE. These streams, the ones in Tom Green County, are running all the time. They are very seldom dry. When you get along the *edge of the* Staked Plain they run during the wet season; but frequently *the beds are entirely* dry—a great many of them.

Senator REAGAN. What stream is this [indicating on map]?
Mr. DUMBLE. That is the Llano.
Senator REAGAN. Have there been any efforts made to take out that stream?
Mr. DUMBLE. Some small efforts. In Llano County, from some of these creeks, there are gardens that have been irrigated, and some fields that have been irrigated.
Senator REAGAN. And some on the San Saba?
Mr. DUMBLE. Yes; and from those streams there are places where they could irrigate large quantities of land.
Senator REAGAN. In the Concho and its tributaries. What do you say about that?
Mr. DUMBLE. That comes in there [indicating].
Senator REAGAN. At the Red Fork of the Colorado. What about that?
Mr. DUMBLE. I can not give you any definite information about that. You have had information about Midland, Odessa, and about there.
Senator REAGAN. Coleman is where they have had fine water?
Mr. DUMBLE. Yes; they have good water there.
Senator REAGAN. Is there any irrigation from the streams in there?
Mr. DUMBLE. I do not know of any irrigation at the present time.
Senator REAGAN. Is it needed?
Mr. DUMBLE. They needed it two years ago, if they could have gotten it in any way.
Senator REAGAN. Do you know whether there have been any efforts at irrigation on the Clear Fork of the Brazos?
Mr. DUMBLE. No.
Senator REAGAN. You have no information that you have collected on that subject?
Mr. DUMBLE. No.
Senator REAGAN. Could you at an early day send any information on that subject to the committee at Washington?
Mr. DUMBLE. Yes, I will do so.

STATEMENT OF CHARLES E. PRATT, OF ABILENE, TAYLOR COUNTY.

The CHAIRMAN. What is your occupation?
Mr. PRATT. Commission merchant.
The CHAIRMAN. Have you observed the effect of irrigation upon the production of crops?
Mr. PRATT. Some; up from the Pecos and in the Pan-Handle.
The CHAIRMAN. Anywhere in western Texas?
Mr. PRATT. Yes.
The CHAIRMAN. State what kind of crops.
Mr. PRATT. Alfalfa; that is about all I have seen.
The CHAIRMAN. What success did you have in raising alfalfa with irrigation?
Mr. PRATT. This season not much; because they could not get the water turned on at Pecos in time.
The CHAIRMAN. I do not mean your success this season, but how water affects it; whether you can raise crops with water.
Mr. PRATT. I do not know that I could state that.
Senator REAGAN. Do you not know whether it makes better crops with water?
Mr. PRATT. Yes, it makes better crops. In Taylor County, had we rain when we needed *it, I know* we would have made fine crops in 1886;

but as it was we made nothing, everything perished for want of water. Last year we made 110 bushels of oats to the acre.

The CHAIRMAN. How far west is that?

Mr. PRATT. Two hundred miles; from 190 to 210 miles.

Senator REAGAN. In what county?

Mr. PRATT. Taylor County.

The CHAIRMAN. You raise good crops there without irrigation?

Mr. PRATT. Yes.

The CHAIRMAN. How often?

Mr. PRATT. Once in every three or four years.

The CHAIRMAN. Then you have failures?

Mr. PRATT. Yes; we have four failures out of six there.

The CHAIRMAN. Then you must irrigate?

Mr. PRATT. Yes; that is the way we look at it.

The CHAIRMAN. What are the opportunities for irrigating there?

Mr. PRATT. I have not thought about that. Could we get water when it is needed, I know we could make splendid crops.

The following papers were ordered filed when received.

Adjourned.

FURTHER STATEMENT OF FRANK E. ROESLER, ON IRRIGATION UPON THE TEXAS STAKED PLAIN.

DALLAS, TEX., *September* 2, 1889.

The Great Plain, where traversed by the Texas and Pacific Railway, constitutes a table-land about 65 miles in width, widening out northwardly, and extending into the Pan Handle several hundred miles. Its most southerly point is about 60 miles south of Midland, Tex. Its outline is well defined, its edges consisting of rocky bluffs extending for hundred of miles, forming many bold promontories and shelters of coves. At some remote period of time its eastern edge was the shore-line of some great sea, which, as it receded eastwardly and southwardly, cut new shore-lines, converting the stretch of country between the plain and the Brazos River into a series of benches or table-lands, lying one above the other like the steps in a stairway. The Brazos River at the Texas and Pacific Railway crossing has an altitude of 750 feet, while the last step in the grand stairway, the eastern edge of the plain, has an altitude of 2,700 feet.

Before the creation of the Pecos Valley the plain seems to have been continuous with the eastern slope of the mountain ranges of New Mexico and western Texas. This would appear from the fact that the surface of the plain presents a gradual fall from the north and west toward the southeast, the altitudes from its western to its eastern edge being as follows: Douro Station, 3,100 feet; Odessa, 2,900 feet; Warfield, 2,875 feet; Midland, 2,780 feet; Marienfeld, 2,700 feet; the southern edge about 2,300 feet. Through some convulsion of nature a break in the strata was formed near its eastern edge, forming what is now known as Suphur Draw, in Howard County, and probably several other fractures will be found north and west several hundred miles distant. This would seem to be indicated by the fact that the strata of the plain are continuous, and that water is usually found in abundance below the limestone, and that this supply does not seem in the least to be disturbed by either heavy local rains or long periods of drought. The water seems to come for a distance of hundreds of miles, and wherever the limestone is penetrated the supply is permanent. The local rain-fall seems to find its way through the various "draws" to the headwaters of the Colorado and Concho Rivers, and is eventually carried to the Gulf of Mexico, or passes through Red River into the Mississippi. The dark colored "rises" of the Colorado River always indicate local rains in Central Texas, and the "red rises" heavy rains on the Staked Plain. These rivers carry off the surface drainage. The underground drainage, namely, the waters under the limestone strata, work their way to the San Marcos, San Antonio, Guadaloupe, Nueces, Sabinal, and many other rivers, which rise and fall at the same time that do the Rio Grande and the Pecos, both of which receive their waters from the mountain snows of New Mexico and Western Texas.

The "draws" above mentioned seem to be able-bodied rivers that have retired from *business. In times* gone by they have carried great volumes of water, and have cut *their way through* solid limestone ledges, their banks being well defined to this day.

During heavy rains they resume business in a small way, occasionally drowning a flock of sheep that are feeding on their grass-covered beds. Generally the water is lost in a few days, having percolated through the sand to the limestone layer beneath, which is generally impervious. Most of these "draws" are filled with silt and sand blown in from the plain. They drain many hundreds of miles in area, and in many of them water in great quantity is found at a depth of 2 to 20 feet. Several could, without great expense, be again converted into flowing streams, carried to the higher lying lands, and be made to irrigate a considerable area. Mustang Draw, in Martin County, by the use of 5 or 6 miles of flumes, could probably be put to good use in this manner, as water in abundance is found at a depth varying from 2 to 6 feet. All the "draw" water will, of course, be surface water, derived from local rains.

The "underground water" is generally found at varying depth. At Marienfeld, on the eastern edge of the plain, at from 60 to 90 feet; at Germania, 10 miles west, at 45 to 60 feet; at Midland, 20 miles west, at 35 to 50 feet; at Odessa, 40 miles west, at 30 to 50 feet; at Douro, near western edge of the plain, none. In a few localities "joint clay," a water-proof material, on which the "underground" water rests, comes close to the surface. No water was found, though this material has often been penetrated to a depth of 500 feet. A few of the surface wells are brackish and several salty, but generally the water is good. Several springs containing soda, sulphur, or gypum water, as well as a few wet weather salt lakes, are also found on the plain. The only permanent running stream on the Staked Plain is "Running Water,', in Dickens County, a bright, sparkling stream, that suddenly breaks out out of the ground, ripples over a pebbly bottom for a distance of 10 miles and then mysteriously disappears, like many other streams west of the Pecos River, notably Leon Wells, Comanche Springs, Escondido, Limpia, and Toyah Creek, or the underground river near Castle Mountain, in Crane County, which is working its way to daylight by washing away the roof covering it, occasionally causing a part of it to fall in. A similar stream exists in the northern part of Crocket County, which was not known to exist a few years ago, though a recent cave-in exposed an abundant water supply 20 feet below the surface.

Nearly all the wells dug or bored in the "under ground" water, under the limestone, show a tendency to rise above the point where first water was reached. In some localities a rise of 20 to 30 feet was observed, showing that the supply is under considerable pressure. Borings at Odessa have shown five separate layers or deposits of water to exist between the surface and the "joint clay" 100 feet below. Between the Staked Plain and the Pecos River is an ancient fresh-water lake basin, known as "the White Sand Hills," which is covered with numerous ponds of pure fresh water. The supply is permanent, and said to be inexhaustible. The railway wells at Monahans, in this locality, furnish an immense supply. Altitude, 2,629 feet. The wells west of this and to the Pecos draw their supply from the seepage of the Pecos River. East of the Staked Plain the water supply in wells is variable as to quantity, quality, and depth. In Howard County good water is abundant in the southern part, rather deep in the northern part, and brackish in the town of Big Spring. In Mitchell County, generally good at 30 to 50 feet, sometimes strongly alkaline. Several wells bored are capable of furnishing 9,000 gallons of water per hour continuously. At a depth of 200 to 300 feet super-saturated salt brine, claimed to be chemically pure, is found in inexhaustible quantity, and a fine grade of salt is manufactured. The Colorado River carries water in its bed nearly all year round. Its water here is said to be brackish and salty. A chemical examination will have to determine whether or not the water can be used for purposes of irrigation.

PRODUCTS OF THE PLAIN.

Farming as a distinct business was begun as early as 1882, and that without irrigation. The highest yield obtained is as follows: Wheat, 25 bushels; rye, 22 bushels; corn, 65 bushels; oats, 50 bushels; potatoes, 150 bushels. Farming operations since 1882 have shown that all varieties of forage plants, including sorghum, millet, alfalfa, Johnson grass, rye, etc., do very well without irrigation, and can be relied on. Wheat, corn, and other crops which are grown especially for their seed, must mature at a specified time. If the rain-fall is timely a large crop will be made, but there is sufficient uncertainty to prevent their becoming (for some time to come, at least) the principal source of income. It is generally conceded that it is useless to plant a wheat crop after a dry fall. A large wheat crop can, however, be made if the country has had good rains in October and November. One good rain in April or beginning of May will secure the crop. It has been frequently observed that two adjoining fields of corn will show the greatest difference in the yield for the reason that the one crop was planted a week or two earlier than the other. The earlier planting would make 10 bushels, while the later planting made 65, though both received a good rain at the same time. The rain-fall of the plain varies between 18 and 42 inches, and this quantity regularly distributed would be ample to secure any crop; but its precipitation

is irregular, and the farmer has unwillingly come to the conclusion that he must have an additional source of income in order to prosper.

The native grasses are abundant and nutritious, and most farmers have acquired more or less live stock, cattle, horses, or sheep, to make the annual income more certain.

The soils as a rule are very fertile, and some of the early settlers from California pronounced them well adapted to fruit-growing, provided water for irrigation could be had.

The drought of 1886 and 1887, more than anything else, brought the question of fruit-growing and irrigation to the foreground. Old wells, used for household purposes only, were increased in capacity, one-half acre gardens were put under irrigation, and found to be very profitable. Experimental orchards were established at Odessa and Marienfeld. Much of the nursery stock was obtained from California, and nearly every variety of fruit grown in the United States, excepting the citrous fruits, can be found on the plain. The experiments carried on for several years by private citizens, and by the experimental farms, have demonstrated that, in addition to all the standard American fruits, the commercial prune and all the raisin grapes and the fancy table grapes of California can be successfully grown. It is now generally conceded that the money-making crop of the Staked Plain will be the fruit crop, and the reasons given therefor are, *first*, that European table and raisin grapes can not be grown further east than the Staked Plain, owing to the humidity of the atmosphere in the lower-lying lands of the Mississippi basin or the Gulf shore.

Second. That all fruits mature fully and are free from blight, premature rot, and obnoxious insects; that all Western fruits contain more sugar and are sweeter and juicier than any of the fruits of the low lands.

Third. That the dryness of the atmosphere has the tendency to modify the effects of severe frosts, it having been repeatedly observed that a much less degree of cold would kill the fruit blosoms in central and eastern Texas, whereas a severe freeze, several degrees colder, on the plain would be perfectly harmless.

Fourth. That while the fruit crop of central and eastern Texas is frequently a failure, owing to excessive rains, this danger is not anticipated on the plain.

Lastly. The fine fruits of the plain are 1,200 miles nearer to the great cities than are those of California, and as the same varieties can be produced it is obvious that the fruit of the plain ought to be more profitable, as it will reach the market in better condition and costs less in the matter of transportation.

THE QUESTION OF OBTAINING AN ADEQUATE WATER SUPPLY IS PARAMOUNT.

The question as to the practicability of raising the finest of fruits is definitely settled. Cheap water is wanted. It can only be obtained in small quantities from wells and storage reservoirs, and the acreage that can be irrigated from each source of supply is limited. The development of the plain will depend largely upon the cost of securing and raising water for irrigation. What has been accomplished through private efforts in a small way only goes to show that present methods are too expensive, and that very few can avail themselves of irrigation by individual effort. Corporations with ample capital can secure sufficient water at moderate cost, but it is questionable whether men with money to lose can be induced to invest in enterprises where success is to some extent problematical. Moneyed men prefer to deal with known quantities. If it is known that a certain quantity of water can be had at a certain depth, that it can be reached at a certain cost, and put on the land at a certain cost per acre, and that the combined cost is sufficiently low to enable a farmer to profitably cultivate and pay for the improvement, there is no question but that the capital neccessary to make the improvement will be at hand. But to determine these points the money will not be forthcoming. As at least 95 per cent. of the arid lands must be irrigated from wells or remain uncultivated, it appears that the people of the arid region will have to look to the national Government for the information that is necessary to secure the investment of capital for irrigation of the plains away from the rivers.

On the Staked Plain but very little water will be needed, but when needed is needed badly. Continuous irrigation is not required. In the history of every crop there is a critical moment in which it is determined whether or not the farmer shall have a full crop, a half crop, or a failure. A rain-fall to-day makes his crop, a rain-fall two weeks hence does him no good. One or two, or possibly three, rrigations during the year, each equaling a two-inch rain-fall, would bring him a great harvest. More than that he will hardly need. In 1888 and 1889 he made a full crop without irrigation; in 1886 and 1887 he did not get his seed back, though the rain-fall of each year, if properly distributed, would have made splendid crops.

The acreage that can be irrigated from a six-inch bored well in a dry year, by using *a ten-foot* windmill, will be about five acres, varying with the rain-fall. By the *use of a suitable* storage tank the capacity of the plant may possibly be doubled, but

at all events the acreage irrigated is very small compared with the cost of the outfit which runs between $200 and $350. Five acres under irrigation by a $200 plant, will cost the owner $40 per acre, and if he borrows the money, paying 10 per cent. interest, he practically pays a water rent of $4 per annum.

This expense is for water alone. If the farmer plants fruit trees and grape-vines he must have rabbit-proof fencing, which may cost him $10 per acre additional. Comparatively few new settlers will be financially able to incur such expense as is necessary for a good water plant, and if they do succeed in securing their water supply it will be at such cost per acre that very high-priced crops must be grown and successfully marketed to meet the interest on the investment to be profitable. The raising of the cereals and forage crops by irrigation will, therefore, be entirely out of the question, but if the cost of the water supply can be reduced, the growing of early vegetables, fine table grapes, early fruits, raisins, prunes, and the making of wine can be made profitable. In order to ascertain the cost of water supply on a larger scale, and also to learn what varieties of fruit are best adapted to the Staked Plain, a number of citizens of Dallas, Fort Worth, Colorado City, Marienfeld, and Midland, agreed to risk the sum of $5,000 in experimental work, and for that purpose organized the Marienfeld Fruit-growing, Gardening, and Irrigation Company. A study of the questions before them has led them to the conclusion that corporations with sufficient capital in hand can safely and profitably develop the plain, and furnish water, the necessary appliances for raising and storing the same, fence lands, build houses, plant trees and vines, market the products, for 25 to 50 per cent. less money than any individual can furnish the same materials, appliances, or conveniences for, and still make a fair profit on the investment.

The estimates on a section of land near Midland or Odessa, where the presence of water in sufficient quantity has been determined by previous tests, are given as follows:

640 acres of land, at $3 per acre	$1,920.00
704 fence posts, at 15 cents	105.60
1,408 stays 1x6 (704 feet of lumber)	35.00
7,200 lbs. Glidden barbed wire, at 5½ cents	396.00
21,220 feet 30-inch netting, 1½ inch mesh, No. 19 wire	462.00
Freight on same	50.00
4 gates, staples, hardware	75.00
30 adobe or box houses, at $150 each	4,500.00
27,040 young fruit trees and freight, at 10 cents, for 160 acres	2,704.00
64,000 young rooted grape vines, at 5 cents, for 160 acres	3,200.00
Office of superintendent	250.00
Salary of superintendent three years, at $720	2,160.00
Wages, five farm laborers two years of three hundred days, at $1.25 per day	3,750.00
Surveying, freights, commissions, advertising, etc.	2,200.00
Farming implements, live stock, etc.	500.00
	$22,307.60

The total cost of improvement per acre will be $34.85, or $22,307.60 for the section.

All of the land is put in tillable condition, but only one-half is planted in trees and vines.

There is a delightful uncertainty as to quantity of water obtainable, size and capacity of wells, windmills, and storage tanks required. The estimate will vary with each section of land used. The estimate on a certain section of land which the writer has in mind is as follows:

Seven dug wells, tunneled in water-bearing strata, at $1,200	$8,400
Seven 30-foot windmills, pumps, towers, etc., at $700	4,900
Ten storage tanks, at $350	3,500
Six miles of wooden flumes, etc.; 95,000 feet lumber, at $25	2,500
	$19,300

An average cost of $31.10 per acre for water.

Adding together the cost of the improvements $22,307.60, and the cost of water supply, $19,300, we have a total cost of $41,607.60, or $65.01 per acre.

The foregoing estimate is an extra liberal one. Fruit-trees at wholesale figures can be had for cash as follows: Apple-trees, $3.50 to $80 per thousand; pear-trees, $100 to $200 per thousand; plum-trees, $100 to $150 per thousand; peaches, $30 to $50 per thousand; grape-cuttings, $2.50 to $5 per thousand; rooted vines, $10 to $100 per thousand; shade-trees, $10 to $150 per thousand. If the company making the improvements grows its own nursery stock, it can produce nine-tenths of the trees and vines at a cost of one-half to 4 cents, and many for much less money. The labor charged against improvements *will also be employed* on the water supply, and perhaps 25 per

cent. gained in construction. The quantity of water required per year will be the equivalent of a rain-fall of 12 inches, the lowest annual rain-fall at Marienfeld being 18 inches. To give each acre the equivalent of a rain-fall of 30 inches, 12 inches, or 325,848 gallons, per annum must be supplied. To give a section 12 inches, 208,542,720 gallons must be furnished during the year, which can be furnished by five Knowles steam-pumps, raising 5,000 gallons per hour, or 120,000 gallons, per day each. A properly constructed well, costing $1,200, should yield double this quantity per day in the vicinity of Midland or Odessa, and in such event three wells may be expected to furnish the quantity of water for which seven wells are allowed in the estimate. If four-sevenths of the cost of construction can be saved, the cost of the water supply can be reduced to about $15 per acre.

A section of land improved and supplied with water as above outlined could be subdivided into 20-acre tracts and sold on easy credit terms to a fruit-growing colony. Each of the 20-acre tracts, according to the estimates above given, will cost $1,300, though it is the opinion of the writer that this amount can be safely scaled 25 per cent. If 50 per cent. be added as profit to the $1,300 the sum will still be from 25 to 50 per cent. less than local retail prices for the same material and labor. If the land and improvements were sold on ten annual payment terms, with 6 per cent. interest on deferred payments, the purchaser could easily meet his obligations, as one single acre in onions or grapes, and other fruit, should earn enough to make the annual payment. The investment made by a company of this kind would be eminently safe and legitimately profitable.

Another estimate on cultivation and irrigation of a section of land, only 160 acres being planted in trees and vines, and no houses being built for the settler, places the sum total at $23,555 or $36.85 per acre.

A 20-acre vineyard on the Rio Grande, carried to the third year's cultivation, is estimated to cost its owner $1,175, or $58.75 per acre. The difference in cost comes in in the increased price of the land, $25 per acre, and the fact that the owner does not own his water supply but must buy it. Besides, he must irrigate oftener and use more water, owing to the different character of the soil and the difference in the rainfall, the maximum at El Paso being 16 inches per annum, and the minimum being 18 inches at at Marienfeld.

An acre in grapes three years old is claimed to produce 16,000 pounds to the acre at El Paso, which, converted into wine, is said to equal 700 or 800 gallons, selling at 75 cents to $1 per gallon. Shipping grapes sell at about 2 cents per pound, which would make the crop worth $320 on the ground. A bearing vineyard, three to five years old, is considered as worth from $300 to $500 per acre. Land on the Staked Plain sells at prices ranging from $2 to $5 per acre, is of easy cultivation, and produces fruits of the same kind and class.

On the Staked Plain and in the mountain valleys west of the Pecos there are many hundred places where flourishing fruit-growing colonies could be established, if only the location, quantity, and cost of the upland water supply were known, and this applies to the entire arid region extending from the borders of Mexico to the British Possessions. Millions upon millions of idle capital are lying in the Eastern banks awaiting investments that will secure a certain and reasonable interest. If competent information can be given on the subject (and who can be more competent than the National Government after due investigation?) much of this capital will become available, and a subsistence be furnished for the millions of American citizens now growing into manhood. These fruit-growing colonies will become small trade centers around which will cluster numerous other industries, such as the raising of live stock, dairying, the growing of wool, the development of mining industries, and of the wealth of fiber now annually going to waste in the mountain valleys of Western Texas.

The crowning work of the century in the way of national legislation will be the making of proper provision for the study of the underground water-supply for purposes of irrigation, and connected with this a study of the adaptability of the various soils to the most profitable and necessary crops.

The writer would respectfully suggest to the honorable Senate Committe that legislation be recommended, to the end that observing stations be established under the joint control of the U. S. Geological Survey and the Department of Agriculture, at places, say, a hundred miles apart throughout the arid region. The observers placed in charge should keep a record of the rain-fall; a record of the temperature, of the wind movement; the period of germination and maturity of unirrigated as well as irrigated crops, together with information as to cost and profit of growing them; should furnish descriptions of existing streams, lakes, springs, dry watercourses, locations for reservoir sites, furnish history of existing wells, reservoirs, cost of same, and cost of appliances and methods of raising water either for ranch purposes or irrigation, describe the soils in their districts and the strata passed through in the *different* wells; in short, gather all possible information bearing on the subject of *water supply*, *irrigation*, and agriculture.

The observers should be supplied with suitable machinery to make test borings for water, and to determine the quantity of water available for purposes of irrigation under any given area of surface. (As long as the arid region is dependent upon the professional water-hunter, who, armed with a forked mesquite switch, puts in time at $5 per day tramping over the country until his employer gets tired, and then suddenly experiences a flea-bite, which he mysteriously calls a magnetic shock and points out a suitable location for a well, little progress can be made.)

The search for water must be systematically made, and the observer must be guided largely by the arrangement of the strata of his district. The presence of water having been determined, its quanity must next be ascertained, and for this purpose I have only one method to recommend, though perhaps better methods may be known to the U. S. Geological Survey.

The observing station should have at its disposal a prospecting diamond drill, which will preserve a cone consisting of every material penetrated; also a portable steam-pump capable of extracting 5,000 gallons of water per hour. Wherever the soil is so constituted that it will grow crops if irrigated, and a considerable area of surface lies favorable for irrigation the test for water should be made. If the water is found in limestone, it will probably run in veins or crevices. Drilling should be suspended and the steam-pump put to work. By observing the time required to empty the well, and the time required to refill, the capacity of the well per diem can be determined. After the quantity is known, it is important to know whether or not the capacity can be increased by opening up neighboring fissures and crevices, thus admitting more water. This can be done by exploding a quantity of dynamite in the bottom of the boring. If no better results are obtained the drilling should be continued to a lower deposit of water. If the quantity of water in the limestone is increased by the use of dynamite, five or six additional borings within a radius of, say, 25 feet should be made and a charge of dynamite exploded in each, which will have the effect of breaking the strata and practically making one well of the entire lot. If the quantity of water thus obtained is sufficient and economical for purposes of irrigation, the object sought for is obtained. The problem to be solved in the experiment is, whether more water can be obtained from combined wells in the fractured rock, than from the six or seven wells singly in the unbroken limestone.

As soon as the water-bearing capacity of the limestone has been determined, the drilling should be continued to the first water below the limestone. Water will probably be found in coarse sand or quicksand. If found at a reasonable depth, say at 100 to 200 feet, a few additional wells of same depth and diameter should be bored respectively 50, 100, 150, 200 feet distant. All these wells should be in line. The wells are numbered respectively 1, 2, 3, 4, and 5. If a steam-pump of 5,000 gallons capacity per hour be attached to the middle well No. 3, the water contained therein will be exhausted. If the pump has worked four hours, 20,000 gallons of water will have been raised. Measurements taken, say, four hours later show that the water in the well has again reached its normal level. If the well can be emptied and refilled every eight hours, the capacity of this well will be 60,000 gallons in 24 hours, sufficient to irrigate 2½ acres per day. Next it is necessary to determine from how great an area this supply of water is drawn. All the wells should be measured and the normal level recorded, then the center well should again be pumped dry, and all the wells measured again as to their water levels. The center well will be found dry; the nearest wells on each side will show a great diminution in their supply; those more remote will also show a diminution, but not so great.

There will be a point where the well most distant from the center will show no loss of water. How far the wells should be apart or how many wells are necessary for the test can only be determined by the nature of the material from which the water is derived, a dozen wells 25 feet apart may be necessary in close-grained sand; less wells at greater distances in coarse sand or small gravel, and in coarse gravel such wells may be 100 feet or more apart. The point where there is no apparent loss of water is the radius of the area from which the water is drawn. If the test mentioned above shows no diminution 100 feet from the center well, the experiment determines the fact that 60,000 gallons of water can be drawn from within a radius of 100 feet in a given locality, and that a stated number of wells in said locality, 200 or more feet apart, can be relied on to furnish sufficient water to irrigate a given acreage, allowing a certain number of inches as the equivalent of the rain-fall needed to perfect a crop. The experiments can be carried on in a number of different ways, by measuring and weighing the material through which the water must pass, as outlined in a letter to the honorable committee, dated July 20, 1889.

The work should not, however, be discontinued after uncovering one or two layers of water, but should be carried on to such depth as the cost of raising the water for purposes of irrigation will warrant. It will remain for the observer to determine from how great a depth water can be pumped and be used for irrigation and still be within a reasonable expense. Another work for an observing station will be the making of test borings in *the thousands of* water courses, coulées, ancient river beds,

draws, etc., scattered throughout the arid region and to ascertain what amount of water they carry and how it can best be utilized. All over the plains are hundreds of small land-locked basins that hold water part of the year but which is lost by evaporation and seepage. Some method will have to be devised to make this water available by raising it to properly constructed storage reservoirs where it can be kept until wanted, and last and not least are numerous underground rivers, whose course should be studied and laid down on the maps so that the water now going to waste can be raised to the surface and be utilized. The co-operation of the Department of Agriculture should by all means be secured for this work. A small experimental farm should be attached to each station and an effort made to determine what products can be most successfully grown and can be made profitable.

The foregoing is in short an outline of what might be done by Congress for the development of the open plains. I have confined myself more particularly to the Staked Plain of Texas, because I am more familiar with it, but the suggestions herein offered apply equally well to any part of the arid region that is distant from running streams or visible supplies of water.

As stated above there is too much uncertainty in the search for water to interest the investment of capital, but if the National Government will supply a reasonable certainty to the effect that a given quantity of water can be obtained from a given area, and that it can be raised at a certain cost per acre, there is no question but that all the private capital needed to develop irrigation from wells can be readily obtained.

PROPOSED EXPERIMENTS IN WELL-BORING.

[Explanation offered by F. E. Roesler, of Dallas, in paper addressed to Mr. Hinton, committee's expert.]

In your recent favor you suggest the propriety of elaborating a little on the plan of experiments suggested by me to ascertain the quantity of water present under a given area of surface. To make my views on the subject clearer I will endeavor to explain it more fully with this little diagram.*

EXPERIMENT NO. 1.

On well No. 7: Section No. 23, block No. 37, township No. 5 south, Midland County, Tex.; open upland prairie, mesquite grass, no underbrush; surface soil; chocolate-colored sandy loam; nearest basin, arroya; draw, pond, or creek is Peck Spring and Salt Lake, N. 45, W. 13 miles; altitude, 2,780 feet.

Diameter of well, 8 inches; depth, 147 feet; surface soil, 15 feet; red clay mixed with sand, 15 feet; clear clay, 10 feet; marly limestone in small bowlders and nodules, 12 feet; compact, bluish-gray limestone, 18 feet; red coarse sandstone, 1 foot; wet white or gray sand, 10 feet; yellow clay, 2 feet (above this water); white or red clay, 15 feet; sandstone, gray or red, 3 feet; gravel water-bearing, 40 feet.

September 20, 1889.—Knowles's steam-pump at work six hours exhausted the well. Water line 6. a. m., 75 feet from surface; at 12 p. m. at bottom, 147 feet. Water extracted, at 5,000 gallons per hour, 30,000 gallons. At 3 p. m. measured water line at 100 feet; at 6 p. m., water line at 75 feet.

September 21, 1889.—Repeated yesterday's experiment with the same results. It appears that the quantity of water extracted will be replaced in about six hours.

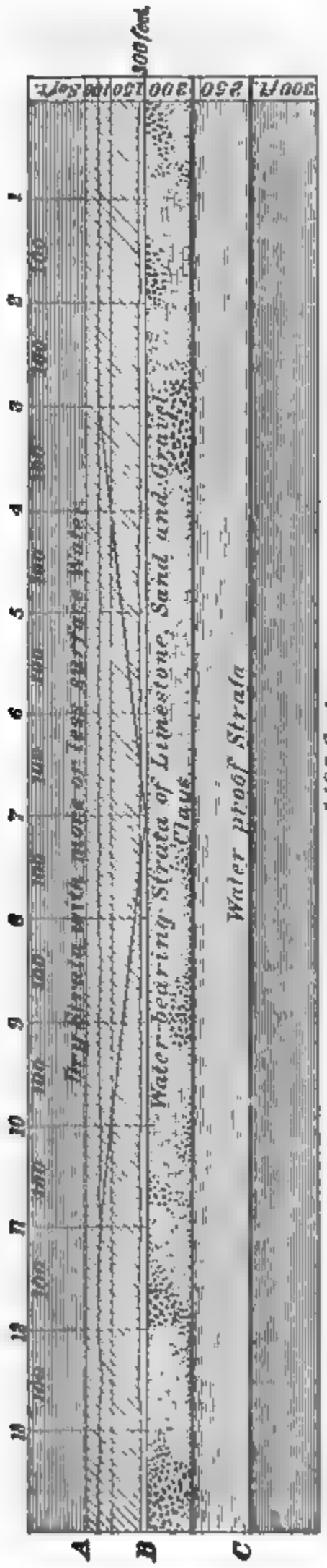
NOTE.—(27,154 gallons will cover 1 acre 1 inch deep. Capacity of well will therefore permit 1 acre to be covered 1 inch deep every day. The lowest rain-fall of this locality being 18 inches, only 12 inches per acre per annum will be required to bring the average to 30 inches, which will be ample and sufficient. Twelve days' pumping will therefore do for 1 acre, and by using the well every day for three hundred and sixty-five days 30 acres could be supplied with 12 inches of water each; that is, pumping only six hours out of the twenty-four. If the pump works also during the night double the acreage could be irrigated. Allowance should be made for waste, excessive evaporation, occasional drought, and time lost an account of repairs to machinery, say one-sixth. It will be safe therefore to estimate the capacity of this well at 25 acres, pumping six hours per day, or 50 acres, pumping twelve hours per day.)

EXPERIMENT NO. 2.

[Supposed copy of observer's note-book.]

September 23, 1889.—Measured stage of water in wells No. 1 to 13, inclusive. Found some slight variations, owing to difference in thickness of the layer of surface soil; the average of the water line is 75 feet. Set the pump to work on well No. 7, and exhausted the well in six hours, extracting, as heretofore, 30,000 gallons. Examined

* See next page.



Explanation: A. Surface soil and dry strata underneath to water line; B. A series of strata containing water (of varying thickness); C. Water-proof clays and other strata; Nos. 1 to 13, bored wells of uniform diameter and depth.

stage of water in all the wells with following results: Nos. 6 and 8, water line at 135 feet; Nos. 5 and 9, water line at 110 feet Nos. 4 and 9, water line at 90 feet; Nos. 3 and 11, no difference visible; Nos. 2 and 12 and Nos. 1 and 3 unaffected. Three hours after above-described examination a second test was made with following results Well No. 7, at 100 feet the water line; Nos. 6 and 8, water line at 85 feet; Nos. 5 and 9, water line at 75 feet; Nos. 4 and 10, Nos. 3 and Nos. 2 and 12, and Nos. 1 and 13, water line at 75 feet.

It appears from the foregoing examination that all the water extracted from well No. 7 comes from within a radius of 300 feet from said well as the wells more distant do not seem to be affected sufficiently to be apparent. It seems also that the principal supply of water is obtained from the 40 foot bed of gravel. The weight of 1 cubic foot of said gravel, having been previously thoroughly dried in an oven, is —— pounds; upon being thoroughly saturated with water and again weighed its weight was —— pounds. Deducting the weigh of the dry gravel, there is a residue of —— pounds of water, —— gallons per cubic foot, and showing the holding capacity of the gravel. A drip, allowing as much water to fall on a cubic foot of said gravel as the same could absorb without overflow, demonstrated that in —— hours —— minutes a quantity of water equaling —— pounds, or —— gallons, could permeate and pass through a cubic foot of gravel. A similar line of experiment made with the layer of sand found at a depth of —— feet in well No. 7 demonstrated that the retaining and carrying capacity was only —— per cent. as to quantity of water absorbed per cubic foot, and that hours —— minutes were required for through passage of the water.

A circle of 600 feet diameter 6.45 acres, will furnish sufficient water for 25 acres of land, pumping six hours per day A second well should not be placed nearer than 600 feet from well No. 7. The experiment shows that only about one-half of the water supply within this circle has been extracted. Pumps placed in wells Nos. 3 and 11 would extract about one-half of this remainder, but would not work to their full capacity, and therefore not be profitable.

The above is an imaginary page from the observer's diary, and will show the nature of the observations to be made. There will be many other questions of interest arising continuously, and should appear on his diary The observer should be well posted in regard to pumping machinery and other matters pertaining to the raising and storage of water. Wherever there is a stretch of country presenting a uniform surface, and there is reason to believe that it can be made arable by

experiments of this kind, it appears to me that it is worth while to try. I confidently believe that nearly all the mesa lands in New Mexico, Texas, and Arizona, that are remote from running streams, can be thus made available, but doubt seriously that private capital can be induced to make the experiments.

DIAGRAM OF PROPOSED WELL.

Dug wells on the Texas Staked Plain. Approximate arrangement and depth of strata in the well on the Haas farm, proposed to be enlarged for purposes of irrigation. The strata encountered vary in thickness in different wells within the distance of a mile. The data here given is approximate and not claimed to be accurate.

IRRIGATION—CENTRAL TEXAS.

[EXTRACT FROM REPORT OF W. F. CUMMINS, FILED BY THE STATE GEOLOGIST.]

The question of irrigation is one so immediately connected with the farming interest in this part of the State that every available supply of water, and every locality of suitable land for that purpose ought to be investigated. With this idea before me have given the matter particular attention during the present expedition. While it is not absolutely necessary to the raising of crops that the land should be irrigated yet the product may be greatly enhanced thereby. There are two sources of water supply; one is the utilizing the natural supply from springs and streams already in existence, and the other is to make larger reservoirs for the storage of the surplus waters of the creeks and rivers. I have examined the many large springs and the perennial streams of this country, and will mention some of them separately, so as to give some definite idea of the adaptability of all of them to the purpose of irrigation.

The first place examined with reference to irrigation was at Lampasas Springs. Here there is a constant and unvarying flow of water from the several springs of 1,440,000,000 gallons of water per day. All of this water can be very easily taken out of the channel and turned on the wide valleys below. In the first 3 miles below the springs there is a fall of 46 feet. The valleys of the stream are broad and level, so that there should be no trouble in getting water over the entire space. The soils are well-adapted to the purpose of irrigation, being black sandy, with subsoil that would retain moisture for a considerable length of time. Although this water is largely mineralized when first issuing from the springs it is not found to be detrimental to the growth of crops, nor does it injure the land after having gone a distance of a mile or two in an irrigation ditch.

There is land enough subject to irrigation in the valleys below to consume all the water supplied by these streams. This water might also be taken out of the Lampasas River at other places than immediately below the city.

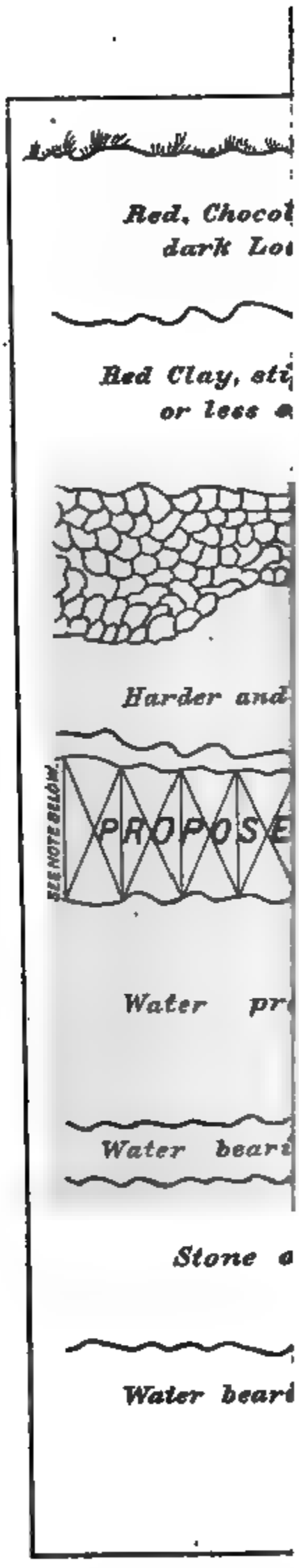
In San Saba County there are several springs along Cherokee Creek that might be used in a small way for irrigation, or the creek might be taken as a whole and used upon some of its broad valleys. The Cherokee Spring, at the head of the creek, furnishes a large amount of water, and at a very small expenditure the water could be carried to the broad valleys below. Already a dam has been constructed across the channel below one of the springs, and at the small expense of a few hundred dollars it could be extended so as to include the water from both springs. This spring is fresh and constant in amount of water it furnishes.

The Flemming Spring, 3 miles east of the town of San Saba, furnishes water to irrigate at least 300 acres of land if properly distributed. It issues from beneath the massive limestone of about the same height as the valley. Already a part of the water is being utilized for irrigating purposes. At one time it was the intention of a former owner to use all the water from the spring for irrigating his farm, but he has been restrained from doing so by an action brought against him by the owners of land below him on the creek made by this spring. A large part of the water now goes to waste.

The Hubbard Spring, a mile northeast of the Flemming Springs, is well situated for irrigating purposes, and furnishes about the same amount of water. It is also used in a small way for irrigation, but the most of the water runs to waste. There is plenty of land in reach of this water to consume it all by irrigation, but the riparian rights of the owners of land below on the stream have been asserted.

The large spring just east of the town of San Saba, which is now used for driving machinery in the flouring mill and for water-works, furnishes a sufficient amount of water to irrigate several hundred acres of land, but it is permitted to run into the river after performing the before-mentioned purposes. A small amount is taken out at the upper dam and turned into a garden and a small field.

On the lands of Mr. Sloan, 10 miles west of the town of San Saba, and on the south *side of the* San Saba River, a fine large spring bursts out from under the massive



NOTE.—This layer o
about 85 feet. Water
always rises to the level

limestone rocks. This spring and branch made by it to the junction with the San Saba River is all on the lands of Mr. Sloan, so there is no one to set up a claim of riparian rights; hence all the water of this spring has been used to irrigate his farm of several hundred acres.

The Richland Springs, at the head of Richland Creek, in the western part of San Saba County, furnish enough water to irrigate several hundred acres, but the water has never been used for this purpose. These springs occasionally in very dry times go dry, but not until after the time when the crops are matured. The lands are good and of such a character as to be well adapted to irrigation. There are sixteen of these springs in San Saba County, and all of them might be used for irrigating the lands in their immediate localities.

The Colorado, Concho, and San Saba Rivers can all be utilized for irrigating their broad valleys and the adjacent plateaus.

The Colorado River would be the most difficult to divert from its channel, as the lands are generally much above the level of the channel. The valleys are of sufficient extent anywhere above San Saba County to consume all the water of the river, and are very fertile.

The waters of the San Saba are abundant, and no trouble would be experienced in taking the water from its present channel and conveying it to the valley above. The valleys are broad and fertile. They now produce fine crops of corn, wheat, oats, and cotton without irrigation, but this yield would be greatly increased by irrigation. There is, however, less actual need for irrigation along this river, and I may say in San Saba County, than in any other of the counties in which my observations have extended.

The Concho River and the country adjacent thereto are more adapted to irrigation than either of the rivers in the district described. The river is more constant in its supply of water, and the plateau of level land above the lower valleys is more accessible.

The South Concho River, Dove Creek, Spring Creek, and North Concho River all have their source at the foot of the Staked Plains. They all have very large springs at the head. None of these springs have a flow of less than 2,000 gallons of water per minute. Irrigation ditches have been taken out on all these streams, and thousands of acres are already under irrigation. In none of these streams has one-half of the water been utilized. The system of irrigation, if it can be called a system, is of the most primitive kind. The farming is mostly done by Mexicans for a share of the crop. Every man takes out what water he wants, and for as long a time as he wants it, letting the remainder flow back into the channel. The next man below him has built a ditch and takes out the water, and so on to the end.

Such is the character of the soil of these streams that they retain a large amount of moisture after having the water from the irrigation ditch spread over them, and numerous springs have broken out along the bank of the river since the plan of irrigating the lands has been put in operation, and instead of the water of the river being exhausted by taking it out and spreading it over these valleys, it is really stored for constant use. There is as much water in the river below the irrigated farms as there was before there was any water taken out. There is really more water now in the Lower Concho River than there was before these irrigation farms were made.

The only reason that can be assigned to this fact is that heretofore all the water was allowed to flow down the channel during the rainy season and at all other times, while now the surplus water is taken out and spread on the valleys above and forms reservoirs and supplies numerous springs with water which before only flowed during wet weather.

The advisability of storing the surplus water need not be discussed in a report like this. The only question that need be considered is whether it can be done successfully and the place where such storage can be made to advantage. It would be a very easy matter to find places along the San Saba River where dams could be made from one hill to the other and an immense amount of water saved for future use. This river runs, from head to mouth, through the massive limestone of the Silurian and Carboniferous formations, and it would be difficult to find places where the water could be stored in reservoirs except along the immediate channel of the river, owing to the height of the surrounding country.

The Colorado River would be more difficult to store water in its channel on account of the material over which it flows and the character of the soil in its immediate valley. But when once the water is taken from the channel it could be conducted to localities where immense lakes might be formed and water stored for future use.

The clays of the Carboniferous formation are impervious to water, and places could be selected where these clays would form the sides and bottom of artificial lakes of immense size. When the time comes for selecting localities for water storage there will be no trouble in finding such places to store the immense surplus of water that at times goes down the Colorado River.

The Concho River furnishes the best locality for utilizing or storing surplus water

of any of the rivers, owing to the ease with which the water may be taken out of the channel and the extensive plateaus which lie contiguous to these streams.

It is possible to make an immense reservoir for the storage of water a few miles below the head of the South Concho River, and the water taken out and used to irrigate the Lipan Flat, a body of land constituting at least one-half million of acres. The lands in this flat are situated so that the water could be taken to any part of them. There is not a better place for such an enterprise in the State.

REPORTS FROM THE STAKED PLAIN AND PAN HANDLE COUNTIES.

[Forwarded by F. E. Roesler, of Dallas.]

ACT TO ENCOURAGE IRRIGATION PASSED BY THE TWENTY-FIRST LEGISLATURE OF TEXAS, 1889.

CHAP. 88.—[S. H. B. No. 298.] An act to encourage irrigation, and to provide for the acquisition of the right to the use of water, and for the construction and maintenance of canals, ditches, flumes, reservoirs, and wells for irrigation, and for mining, milling, and stockraising in the arid districts of Texas.

SECTION 1. *Be it enacted by the legislature of the State of Texas:* That the unappropriated waters of every river or natural stream within the arid portions of the State of Texas, in which, by reason of the insufficient rain-fall, irrigation is necessary for agricultural purposes, may be diverted from its natural channel for irrigation, domestic, and other beneficial uses: *Provided,* That said water shall not be diverted so as to deprive any person who claims, owns, or holds a possessory right or title to any land lying along the bank or margin of any river or natural stream of the use of the water thereof for his own domestic use.

SEC. 2. That the unappropriated waters of every river or natural stream within the arid portions of the State, as described in the preceding section of this act, are hereby declared to be the property of the public, and may be acquired by appropriation for the uses and purposes as hereinafter provided.

SEC. 3. The appropriation must be for the purposes named in this act, and when the appropriator, or his successor in interest, ceases to use it for such purpose the right ceases.

SEC. 4. As between appropriators, the one first in time is the one first in right to such quantity of the water only as is reasonably sufficient and necessary to irrigate the land susceptible of irrigation on either side of ditch or canal.

SEC. 5. Every person, corporation, or association of persons which have constructed or may hereafter construct any ditch, canal, or reservoir, for the purposes named in this act, and taking water from any natural stream, shall within ninety days after this act goes into effect, or within ninety days after the commencement of such construction, file and cause to be recorded in the office of the county clerk of the county where the head gate of such ditch or canal may be situated, or to which said county may be attached for judicial purposes, in a well-bound book to be kept by said clerk for that purpose, a sworn statement in writing, showing the name of such ditch or canal, the point at which the head gate thereof is situated, the size of the ditch or canal in width and depth, and the carrying capacity thereof in cubic feet per second of time, the name of said stream from which said water is taken, the time when the work was commenced, and the name of the owners or owner thereof, together with a map showing the route of said ditch or canal.

SEC. 6. Within ninety days next after the filing of said statement, the party claiming the right to appropriate the water shall begin the actual construction of the proposed ditch, canal, or reservoir, and shall prosecute the work thereon diligently and continuously to completion.

SEC. 7. "Completion," as used in the preceding section, is hereby defined to be the conducting of the water in the main canal to the place of intended use.

SEC. 8. By compliance with the preceding provisions of this act the claimant's right to the use of the water relates back to the time when the work of excavation or construction was commenced on said proposed ditch, canal, or reservoir: *Provided,* That a failure to file said statement shall in no wise work a forfeiture of such heretofore acquired rights, nor prevent such claimants of such heretofore acquired rights from establishing such rights in the courts.

SEC. 9. When any person, corporation, or association of persons, by compliance with the preceding provisions of this act, shall became entitled to the use of the waters in any river or stream, it shall thereafter be unlawful for any other person, corporation, or association of persons, except for domestic use by any one entitled thereto, to so divert the flow of water in said river or stream in such manner and to the extent of depriving said person, corporation, or association of persons in priority of the use of the water to which they may be so entitled.

SEC. 10. Corporations may be formed and chartered under the provisions of this act and of the general incorporation laws of the State of Texas, for the purpose of constructing, maintaining, and operating canals, ditches, flumes, feeders, laterals, reservoirs, and wells, and of conducting, transferring, and furnishing water to all persons entitled to the same, for irrigation and domestic uses, and for the purpose of building storage reservoirs for the collection and storage of water for the uses before mentioned, and for mining, milling, and stock-raising. All persons who own or hold a possessory right or title to land adjoining or contiguous to any canal, ditch, flume, or lateral, constructed and maintained under the provisions of this act, and who shall have secured a right to the use of water in said canal, ditch, flume, or lateral, shall be entitled to be supplied from such canal, ditch, flume, or lateral with water for the irrigation of such land and domestic uses: *Provided*, The party so entitled shall first make available his said land for agricultural or grazing purposes, and shall provide cisterns, wells, or storage reservoirs for water for domestic purposes.

SEC. 11. All corporations and associations formed for the purposes of irrigation as provided in this act, are hereby granted the right of way, not to exceed one hundred feet in width, over all public, university, school, and asylum lands of the State, with the use of the rock, gravel, and timber on the right of way, for construction purposes, and may obtain the right of way over private lands by contract. Any such corporation may also obtain the right of way over private lands by condemnation by causing the damages for any private property appropriated by such corporations or associations to be assessed and paid for as provided in cases of railroads.

SEC. 12. All surplus water not used or disposed of, as provided for in the preceding sections of this act, shall be conducted back to the stream from which it was taken. And all water sold or disposed of may be measured in inches, feet, or fractional portion of the whole supply, or distributed by the hour or acre system. But any person, corporation, or association of persons shall furnish water in the way and manner named in the contract or certificate issued to the purchasers of said water, so long as water remains unsold in the ditch: *Provided*, That the commissioner of agriculture, insurance, statistics, and history shall make a report to the legislature at its next regular session, and at each regular session thereafter, as to the cost and expense attending the construction and maintenance of canals, ditches, flumes, feeders, and wells for irrigation in various parts of the State, and accompany the same with a statement of the charges made for the uses of water by canal, ditch, and well companies, and the legislature shall at such times as it deems proper, either by direct legislation or by the creation of a commissioner or water inspector or inspectors with full delegated power, control and regulate the quantity of water which may be diverted by any water company or individual, when and in the manner in which it may be diverted, and may establish and enforce all such reasonable rules and regulations necessary and proper governing and controlling such corporations and water construction companies and persons operating under the provisions of this act, and may also control, regulate, change, and fix the charges for the use of water made by such ditch, canal, and well companies.

SEC. 13. All said persons, corporations, and associations shall have the right to run along or across all roads and highways necessary in the construction of their work, and shall at all such crossings construct and maintain necessary bridges for the accommodation of the public, and shall not affect or impair the usefulness or condition of said road or highway.

SEC. 14. Any person who shall wilfully or through gross negligence injure any irrigating canal or its appurtenances, wells, or reservoirs, or who shall waste the water thereof, or shall take the water therefrom without authority shall be deemed guilty of a misdemeanor, and for each offense shall be liable to a fine not exceeding five hundred dollars.

SEC. 15. Any corporation created and organized under the provisions of the general laws of this State or the provisions of this act for the purpose of irrigation shall have the power to acquire lands by voluntary donation or purchase or in payment of stock or water rights, and to hold and dispose of all such lands and other property, and to borrow money for the construction, maintenance, and operation of its canals, ditches, flumes, feeders, reservoirs, and wells, and may issue bonds and mortgage its corporate property and franchises to secure the payment of any debt contracted for the same: *Provided*, All lands acquired by said corporation, except such as are used for the construction, maintenance, and operation of said canals, ditches, laterals, feeders, reservoirs, and wells shall be alienated within twenty years from the date of acquiring said lands or be subject to judicial forfeiture.

SEC. 16. All laws and parts of laws in conflict with the provisions of this act are hereby repealed.

SEC. 17. Whereas it is necessary that irrigating canals should be built at once to afford water for irrigational purposes for the present year; therefore an emergency exists, and an imperative public necessity demands the suspension of the constitu-

tional rule which requires a bill to be read on three several days, and that this act take effect and be in force from and after its passage.

[NOTE.—The foregoing act originated in the house, and passed the same by a vote of 69 yeas, 6 nays; and passed the senate by a vote of 21 yeas, no nays.]

Approved March 19, 1889.

STATEMENT OF JOSEPH TWEEDY, OF SAN ANGELO, TOM GREEN COUNTY.

[Secretary of the San José Irrigation and Power Company.]

Having been requested to place before the Senate committee some information in regard to the agricultural resources of Tom Green County, Tex., and how such resources may best be increased or improved by irrigation, I would briefly and imperfectly submit as follows:

Tom Green County, Tex., or perhaps, better to cover the points at issue, those portions of Tom Green and adjoining counties locally known as the "Concho country," comprises some 6,000 to 8,000 square miles in and below the foot-hills of the Staked Plains, or the water-sheds of the North, Middle, South, and Main Concho Rivers and their tributaries, and lies at an elevation above tide-water of from 1,600 to 2,500 feet. That portion of the tract towards the head-waters of the streams is rough and broken, and while affording excellent pasturage is generally unfit for agricultural purposes, except in the immediate river bottoms, which are from one-half to two miles in width.

From and for some distance above the point, near San Angelo, where the various branches of the Concho unite to form the main Concho River, to its junction with the Colorado River, the valley widens out into broad plains with a gradual slope towards the east.

The soil is generally a chocolate or reddish loam, easily worked, of good quality and depth, and underlaid with clay, gravel, or the limestone formation characteristic of this section. The valleys are sparsely covered with mesquite and live oak timber, with pecan and elm lining the streams.

All of the streams mentioned above, together with Spring and Dove Creeks, tributaries of the Middle Concho River, are fed by never-failing springs, breaking out near the foot of the Staked Plains, which in the aggregate are estimated to furnish a minimum flow of from 200 to 250 cubic feet per second.

Owing to the abruptness of the upper water-sheds and the considerable grade of the country toward the east (averaging about 10 to 15 feet to the mile) the streams rise and fall very rapidly after a rain-fall.

Rain-fall.—The average annual rain-fall for the past fifteen years, taken from the records of the United States Military Post of Fort Concho, has been about 20 inches, which on its face would seem to indicate a fair amount of moisture for agricultural purposes.

Owing however to its unequal and uncertain distribution during the year, and the generally extremely rapid precipitation, together with the prevalent hot and drying winds during the spring and summer, the actual benefit of the rain-fall for agricultural purposes can not be measured in direct proportion to the inches of annual precipitation, but must be taken with a considerable reduction.

Irrigation enterprises.—The first irrigation ditch in the Concho country was taken out by Taylor & Spears on the South Concho River, irrigating about 700 acres, and is still in successful operation.

The following is a partial list of the principal irrigation ditches and farms now in operation:

On Spring Creek, William Locky, 300 acres; T. McDonald, 400 acres; James Neill, 200 acres; J. T. McLane, 300 acres; R. F. Tankersley, 500 acres.

On Dove Creek, E. Stilson, 500 acres; San Jose Irrigation and Power Company, 1,500 acres; Scott & Ryan, 300 acres; and R. F. Tankersley, 400 acres.

On South Concho River, P. H. Moris, 200 acres; De Long Bros., 500 acres; Cochran & Wynn, 300 acres; A. Gardner, 300 acres; C. B. Metcalf, 900 acres; M. Sims, 300 acres; Berrendo Stock Company, 100 acres.

On Middle Concho River: J. R. Nasworthy, 300 acres; Capt. J. Foulkes, 900 acres; P. C. Lee, 400 acres.

On North Concho River: Phelan and Glenn, 300 acres; Jonathan Miles, 400 acres; in all about 9,000 acres.

Methods of irrigation.—All the dams heretofore built have been rough and inexpensive affairs, of brush and rock, of from 4 to 10 feet in height, designed simply to divert a portion of the natural flow of the stream into the ditches, which are usually from one-half to 1 mile in length from the dam to the lands desired to irrigate.

Irrigating by furrows is the system generally followed, except in small grain and grass, where the land is cut by low dikes into oblong "melgas" or lands, about 10 yards wide and 100 to 200 yards long, and the water run over each in succession.

By simply diverting the water from the streams by means of the rough dams above mentioned, a farm of 400 to 500 acres can, if favorably located, be put under irrigation at a cost of not to exceed $4 per acre. The cost of keeping dams and ditch in ordinary repair should not exceed 50 cents an acre per annum.

The cost of irrigating 1 acre of land, with the methods and appliances at present in use, is about 20 cents for each irrigation.

Duty of water.—Owing to large losses by leakage and present wasteful methods of irrigating the actual duty of water for ordinary crops is about 50 acres per cubic foot per second of flow during the irrigating season of, say, one hundred days. There have been seasons (notably the present season of 1889) when the natural rain-fall has been sufficient to mature the crops with little or no irrigating. As a rule, however, one, two, or even three irrigations are necessary to insure certain and abundant returns.

Values and rental of irrigated land.—Good dry farming land is worth from $3 to $5 per acre, but where the same land can be brought under a ditch, the value is increased to from $30 to $100 per acre including the water right. The irrigated lands are usually rented either for a cash rental of from $5 to $10 per acre, including the right to the water at stated intervals, or for a share, usually one-third of the crop.

Crops raised.—The usual crops raised, with their average yield, on irrigated and dry lands, gathered from the uncertain data at hand, are about as follows:

Crop.	Average yield on irrigated land.	Average yield on dry land.	Remarks.
Corn	40 bushels	10 bushels	Very uncertain on dry land.
Oats	50 bushels	25 bushels	Fairly certain on dry land.
Wheat	20 bushels	10 bushels	Do.
Rye	30 bushels	15 bushels	Do.
Barley	40 bushels	20 bushels	Do.
Sorghum	2 crops	1 to 2 crops	
Sweet-potatoes	300 bushels	None	
Irish potatoes	200 bushels		Uncertain on dry land.
Alfalfa	3 to 4 cuttings.	None	
Vegetables	April 15 to October 15.		Uncertain on dry land.
Fruit	All varieties.		Some varieties do well on dry land.

Grapes do well on both irrigated and dry lands, although the yield is surer if they can be irrigated just when necessary.

Cotton has been planted to a limited extent for the past two years. That on the irrigated lands has been irrigated once the past season, and now promises a yield of not less than a bale to the acre, of extra long staple. Cotton on dry lands will also yield well the present season, although somewhat less than that irrigated.

In a general way, it may be stated, that while small grain (if planted in the autumn), some fodder crops, a few varieties of fruits, and probably cotton, will yield fairly well in a season of average precipitation of moisture. The yield is largely increased by irrigation; and that for all other crops irrigation may be considered almost a necessity.

Storage of surplus water.—Estimating the duty of water at 50 acres per cubic foot per second of flow during the irrigating season, the ditches now in operation will, in a dry season, divert nearly if not all the natural flow in the streams.

While undoubtedly under improved methods the duty of water will be somewhat increased, to materially increase the acreage under irrigation, there must be adopted some comprehensive system of dams or reservoirs in the upper valleys to store up all the water running to waste during the nine months when not in use, to be conducted by canals or pipe to the lower valley lands.

It is believed that available sites for reservoirs can be found on nearly all the streams, with capacity not only to store the normal flow, but also a large portion of the enormous volume of flood water.

Irrigation by wells.—But little has been attempted in the direction of irrigating from wells, except for garden purposes. Of the many hundred wells in the Concho country, nearly all are for stock or for domestic use. As a rule all wells are drilled and water found at from 25 to 200 feet, with an average depth of about 100 feet. The average capacity of wells sunk in this section has been estimated to be about 500 gallons an hour.

In a number of wells where they have encountered subterranean streams or rivers the yield seems to be limited only by the pumping capacity of the machinery applied.

The writer is informed that pumps of a capacity of 5,000 gallons an hour have been applied to several of these large wells without developing any sign of exhaustion, or lessening the flow.

There have been no attempts as yet to obtain artesian water, although a company is now being organized at this point (San Angelo) for that purpose. Should artesian water be found in sufficient quantities at a reasonable depth, it will undoubtedly be largely utilized for irrigation purposes.

All the lands now under irrigation lie in small detached tracts in the upper valleys or points where the water could most readily be diverted from the streams.

In the lower and broader valleys and plains there are very large and fertile bodies of land, aggregating, at moderate estimate, not less than 400,000 acres, favorably situated for irrigation purposes.

Should the General Government, by surveys of the head waters of the Concho Rivers, demonstrate the feasibility of a system of dams, with sufficient storage capacity, it is believed there will be no lack of private capital to take up the enterprise, and place a large portion of their lands under ditch.

STATEMENT OF E. W. KIRKPATRICK, OF McKINNEY.

In compliance with the request from the Warienfeld Fruit Company, I have, as a horticultural expert, during this month visited the Staked Plains and the Pecos Valley, of west Texas, for the purpose of examining the prospective interests of farming, fruit-growing, and irrigation of that district. I was most favorably impressed with every condition of climate, soil, and production. The climate is about everything that can be desired for the habitation of man and the maturing of the finest products of earth. The soil is uniformly rich and deep, with a strong flow of pure water below, ranging in depth about 30 or 40 feet. Foreign and domestic fruits grow to as great perfection here as in any country.

The altitude being about 3,000 feet, and the extent of these lands being hundreds of miles each way, the air is very pure, and almost constantly in motion, giving fine health and almost perfect development to the most valuable forms of animal and vegetable life. The dry beds of lakes, and the rivers and creeks which stretch through this country, and the rich alluvial red sandy loam of several feet, underlaid with clay, gravel, and constant running water of pure quality, indicates that this plain has at one time been of less altitude and well watered with lakes and streams. The whole surface is covered with rich grasses, beautiful flowers, shrubs, and small bushes.

While visiting these plains I saw many young, vigorous orchards and vineyards of the finest varieties of peach, plums, prunes, apricots, almond, and cherry trees; grapevines, berries, and other fruits showing remarkably large growth, fine specimens of fruit with perfect foliage and no sign of hurtful insect or disease. Vegetables, grain, and sorghum, and all these fruit-bearing plants, were maturing fine crops with little or no irrigation.

The Pioneer Canal Company, at Pecos City, with water from the Pecos River, is demonstrating the wonderful fertility of this soil by producing immense crops of grain, fodder, and vegetables. Since the savage has been driven away, and since the annual fires have ceased to sweep over this land, young timber is springing up everywhere, and the rain-fall, which is 18 to 36 inches, is being better distributed through the year, and if these influences could be accelerated by an entensive system of irrigation by wells and pools, it is my opinion that the waste places of west Texas would soon be converted into one of the richest and most desirable sections of our country, furnishing happy, prosperous homes for millions of our crowding population. During the last three months I have visited in eastern and southern Texas many horticultural fairs, and examined many of the finest orchards and vineyards in this State, but I have never tasted better flavored peaches, Kelsey Japan plums, fine European and native grapes, melons, potatoes, beets, etc., than those of the Staked Plains.

While at Odessa, the acme of the plain, I found sweet-potatoes in a cellar perfectly firm, bright, and sound, and which had been stored ten months. The present sparse population are growing rich with their large herds of fine sheep, horses, and cattle—which feed all the year on rich grass. This immense body of rich land belongs chiefly to the railroad companies and the State and can be bought on most reasonable terms. So soon as the possibilities of this large area can be demonstrated beyond cavil by partial development, extending through a series of years, then will this long neglected land be converted into one of the richest sections of our great country.

STATEMENT OF J. L. VAUGHAN, OF MERKEL.

Merkel is located in Taylor County Tex., latitude 32° 25′, longitude 23° 10′, and is embraced in the "subhumid district." The season of rains begins in March and continues until about the middle of June. The month of July is nearly always dry, and usually little or no rain falls from middle of June until middle of August. The midsummer rains, which nearly always come in August, are very copious. During the fall rains become less frequent and the winters are nearly always dry.

The wheat crop, if sown in October while the ground is still moist, springs up very rapidly and makes a good growth before the cold weather and dry winds of January set in. The absence of excessive moisture during the winter months is beneficial to wheat, rye, and barley, as there is less tendency to freeze out. The heavy spring rains of March revive the plants, and the frequent showers during the months of April and May mature the crop, while the dry weather in the latter part of June and in July is very favorable for the harvesting and threshing of the grain. The yield of wheat is from 15 to 30 bushels per acre. This crop could not be benefited any by irrigation. About 40,000 bushels of wheat were raised in this section this season.

For corn and oats the seasons are not always so favorable, as there are instances when the dry season injures them somewhat before they fully mature. Oats are more certain than corn, and under ordinary circumstances will average 60 bushels per acre. Corn generally averages about 30 bushels per acre. Of the cereals, corn is the only crop that would be benefited by irrigation, as it needs it most in the months of June and July, when it is usually dry weather.

Wheat is selling this season at 85 cents per bushel, oats at 50 cents per bushel, and corn at 40 cents per bushel. Rye and barley have not been much tried here yet, but as they resemble wheat they will be similar in their yield and culture.

The vegetable crops, while usually yielding well, would be greatly benefited by irrigation. It is almost impossible to raise Irish potatoes successfully in this district without some irrigation, and common garden vegetables will nearly all cease during the dry season, unless assisted by irrigation. Sweet-potatoes and the members of the melon family being of Southern origin, stand the dry weather well, and make the most wonderful growth in size with very little rain-fall.

The cultivation of orchards and vineyards would be greatly benefited by irrigation. The peach, nectarine, apricot, and plum grow very rapidly, but where they can be supplied by a moderate amount of water, either by surface or sub irrigation, they will double their growth of tree and yield of fruit. The fig will do well by a little irrigation and slight protection during the first winter. The apple and pear have not been a success, unless where they can be irrigated. The vine grows tolerably well, but with some irrigation it makes a very rapid growth and bears fruit of the finest quality. The absence of blight or mildew is very noticeable. Nearly all varieties succeed, but the mission grape seems to be the best adapted to irrigation.

There is a garden in Merkel where peaches, apricots, plums, persimmons, cherries, pears, apples, figs, pomegranates, and several varieties of grapes are growing and doing well; also in the same garden are strawberries, gooseberries, currants, blackberries, and raspberries; also a number of tropical plants and orchids. Bananas and dwarf species of orange grow and bear fruit, but have to be protected during the winter.

The rain-fall, as recorded at this station during this summer, is as follows: April, .23 inch; May, 2.68 inches; June, 6.33 inches, July 3.04 inches; August, none; September, 3.85. The rain-fall in June and July and absence of it in August this season is very unusual, as it usually begins earlier in the spring and ends in June. This has rather been an "off" year in regard to seasons.

The general topography of Taylor County is similar to the rest of the counties that lie adjoining the Staked plain. The surface of the county is rolling prairie, covered in places by a growth of mesquite timber, and in some places dotted with live oaks. The soil varies from a red to a dark, sandy loam, varying in depth from 2 to 7 feet, and is very productive. A range of mountains runs through the county from east to west. These mountains are about 300 feet high, are abrupt and steep on the north side, but on the south they slope off gradually. They are in fact the end of a plateau that slopes southward toward the Concho River. Several streams head in these mountains and run on the north to the Brazos and on the south to the Concho Rivers.

A large number of water-courses, which in wet seasons are torrents, but in dry seasons have no water, also have their heads in or near the mountains, and cutting across the prairie intersect the different streams. These are feeders during the wet season and help to make the sudden rises so remarkable in the Brazos and Colorado rivers in Texas.

Many of these water-courses could be used very successfully for the storage of water for irrigation purposes. The cost of putting dams up at intervals along them would not be great, and besides furnishing a valuable supply of water for irrigating

purposes and for stock they would tend by their evaporation to make the air more humid and thereby increase the rain-fall.

The western part of Taylor County is remarkable for the inexhaustible supply of water that underlies the country for a distance of 30 miles north and south and 10 miles east and west. Merkel is located in the center of this water district, and has over fifty wells in the town that furnish an abundance of good pure water, which is free from alkalies.

STATEMENTS MADE BY CITIZENS OF MARTIN, GAINES, AND ANDREW COUNTIES.

[Forwarded by N. S. Schmitz, of Marienfeld, through F. E. Roesler, by whom, at request of committee, this northwest Texas testimony was obtained.]

I had the honor to call a meeting of settlers, of Martin, Gaines, and Andrew Counties, in northwest Texas, to the end of obtaining such information relative to irrigation, water supply, fruit-growing, and gardening, as well as raising field crops, for the use of the United States Senate Committee on Irrigation, as will enable said committee to form a correct opinion of our part of the State.

The meeting took place September 18 at the office of J. B. Konz, at Marienfeld, Tex., Dr. L. N. Moller, chairman; N. S. Schmitz, secretary.

The first witness examined was Mr. J. B. Konz; lives on section No. 13, township 1 south, block 36, adjoining the town site. Witness said the only way we can irrigate is from wells by the help of wind-mills and pumps; has one dug well 61 feet deep. Its costs about $1.75 per foot to dig a well. Thinks bored wells more expensive on account of the iron casing required.

Witness thinks an earth tank can be made anywhere hereabouts without much expense. He thinks he would use the clayey soil out of our natural basins and cover bottom of tank to the thickness of about a foot, and have it well tramped while moist. Thinks a great variety of fruits, especially the grape, can be successfully raised by irrigation. Has lived in this county seven years and one year in central Texas, near Austin; considers this section of country capable of producing fruit of better flavor than central Texas; considers fruit-raising very profitable, since owing to the fine flavor of the fruit raised here it will bring good prices. He thinks field crops uncertain without irrigation and doubts whether these crops would warrant the expense of irrigation. Says water can be found in liberal quantities almost anywhere in the vicinity of Marienfeld by digging or boring for it. Thinks a common well with pump and 12-foot wind-mill capable of irrigating 2 acres in vegetables and 6 acres in fruit-trees; considers it a day's labor to apply water for irrigation to 1 acre in vegetables. Does not think it safe to raise fruit or vegetables without irrigation.

The second witness examined was Joseph Gittinger, of Marienfeld. Lives on section 11, township 1 south, block 36, 1 mile from town. He believes in irrigation from wells. He applies it by letting the water run in open ditches over the ground. The ditches to be from 2 to 3 feet apart for vegetables. Has one dug well 80 feet deep, with pump and 12-foot "challenge" windmill. Pump has 3-inch cylinder and 1¼-inch pipe, and furnishes 10 gallons of water per minute. Made the well himself; used $30 worth of dynamite and caps. Pump and windmill have cost $130. Would recommend earthtanks, which he thinks will not leak when well tamped.

Witness considers this county and surrounding country well adapted for fruit-growing and gardening. Had fourteen years' experience with irrigation in San Antonio, Tex. Is sure this part of Texas is better than Southwest Texas or California if water can be applied to the crops. He is of opinion that grapes, onions, sweet potatoes, and tomatoes can generally be raised without irrigation, but they grow more perfect when irrigated. His well is inexhaustible. With his pump and windmill he can irrigate 3 acres in vegetables. By adding a large tank he could water double that quantity of land. He says it takes four hours to irrigate 1 acre in vegetables.

The next witness was J. B. Robertson, who lives on section 20, township 1, south, block 38, about 18 miles west of Marienfeld. Mr. Robertson and his brother C. H. Robertson have six wells. Five of them are dug wells, one a bored well 51 feet deep. The dug wells are from 35 to 45 feet deep. All these wells are inexhaustible. On section 20, where he lives, he has a double-action pump, with a 3½-inch cylinder, operated by a 12-foot "Halladay" windmill, capable to irrigate from 5 to 7 acres in vegetables. He runs the water in open ditches over the ground. Has had fifteen years' experience in irrigation in Southern and Central California. Considers soil as productive here as in California if water is applied. Has grapes and peaches now bearing that are as fine as in California. Other young fruit trees make as good growth as in California. Has irrigated land in this part of Texas the last four years. *Has raised* sorghum successfully without irrigation for three years on same land. *Always found* water wherever he tried. Dug wells have cost him $1.50 per foot.

A. Rawlins, Marienfeld, is a strong believer in irrigation from wells and reservoirs. He says he would recommend earth tanks, rendered impregnable with alternate coats of pitch, tar, and sand. Considers fruit-raising a very profitable business for this part of Texas. Says we can beat central Texas and California. Claims that irrigation is to be preferred to dry culture or any other mode. Thinks water can be obtained anywhere in this portion of Texas. Has a well 4 feet deep on section 24, township 1 south, block 37, 5 miles west of Marienfeld. He estimates that with a shallow well, with pump and windmill, the cost of a water supply for irrigating 5 acres of land, including a small tank, will be about $150; in a deep well it will be about $300. In his experience it will take from four to six hours of work to lead water over 1 acre in vegetables; if land be planted to fruit trees it takes less water and less time to irrigate it. He also says he never tried to raise anything without irrigation, not thinking it would do any good.

Dr. L. N. Moller, Marienfeld, was the next witness. He is in favor of irrigation from wells, and besides would recommend making reservoirs on the side of a slope wherever it is practicable to do so, and catch rain-water from elevated lands, and distributing it over land farther down these slopes. Has one well on section 15, township 1 south, block 36, 90 feet deep.

Witness thinks earth tanks can be made cheaply on high points, and filled from wells during the winter months, and the water thus gathered to be used in summer. Says he has no experience of his own in fruit-growing, but from his observations in California, Oregon, Nevada, and Utah and Washington Territories he considers this part of Texas superior to any of them. He thinks grapes and peaches will do as well here as anywhere. Witness further says: "I do not think central Texas can compare with this portion of the State as far as fruit-growing is concerned. I have lived there four years, and I find this part much superior, especially for grapes. I think everybody who attends to grape-growing rightly must become rich at it. I do not think grapes need much irrigation after the first year. I think alfalfa would do well without irrigation. I have seen it grow well on a side hill near Salt Lake, Utah Territory."

The next witness was Prof. G. H. Seymour, of Marienfeld. He thinks grapes will grow without much irrigation. Our peaches and grapes here have a very good flavor, and, I think, will remain free from diseases to which they are subject in more moist a climate. I think our fruit and grapes bear shipping long distances. I have great faith in the future of this country as a fruit-growing country.

Joseph Karl, Marienfeld, was the next witness. He thinks the best method of irrigation is with artesian wells; such wells could be sunk easily in Martin County and all over the Staked Plains. Has seen such wells in Hungary and Servia. Considers this portion of Texas excellent for fruit growing—better even than Hungary. Thinks we can raise wine as good as the Tokay of Hungary if we adopt irrigation. Considers grapes and fruits very profitable if raised by irrigation. Has planted rye, corn, and sorghum without irrigation. The rye was 4 feet high, but did not fill on account of drought. Corn made about 10 bushels per acre. Thinks an acre in fruit-trees can be irrigated from a well in two hours. Has been engaged in grape and fruit growing in this county for three years.

Isaac Gardener lives 12 miles northwest of Marienfeld; has three wells, one 28 feet deep, one 40 feet deep, and one bored well 63 feet deep. Has a pump and 10-foot "Halladay" windmill on 28-foot well, from which he can water twenty-five hundred head of cattle, equal to 25,000 gallons of water per day. Cost of boring wells, $1.50 per foot.

P. M. De Witt, living 18 miles west of Marienfeld, has three wells, one 20 feet deep, one 22 feet deep, and one 35 feet deep. Has one 12-foot "Halladay" windmill and one "Bird" mill. His wells are also inexhaustible.

Robert Bartlett, on his ranch 20 miles northwest of Marienfeld, in Martin County, has eight wells and seven windmills. The wells are from 35 to 63 feet deep and inexhaustible.

Frederick Sommers, Marienfeld, said: Witness lives on section 15, township 1 south, block 36, one-half mile west of Marienfeld. Has one well 70 feet deep, with pump and "Challenge" windmill, from which he watered one hundred head of cattle and irrigated about 1 acre in vegetables. Considers irrigation from wells a success for fruit-growing and gardening. Has lived here five years. Has raised field crops without irrigation every year, though, with the exception of sorghum, the returns were light, owing to dry summers. He believes in earth tanks.

Louis Kochs, Marienfeld, lives on section 17, township 1 south, block 36; has two wells both 85 feet deep and inexhaustible. On one of these wells he has a 10-foot iron turbine windmill. It furnishes about 600 gallons of water per hour.

George Matzee, Marienfeld, lives on section 25, township 1 south, block 36, 1 mile south of Marinfeld. His well is 70 feet deep and inexhaustible; has the greatest faith in northwest Texas as a fruit-growing country. His one and two year old grapes all bore fine fruit this season. Many of his two-year-old grapes have bloomed and are

now bearing a second crop. He firmly believes in irrigation from wells. He considers this part much superior to Bohemia, his native land, as a fruit country; has planted tobacco successfully for several years with irrigation.

John Pagendarm, Marienfeld, lives on section 1, township 1 south, block 36, 2 miles north of Marienfeld; has grown vegetables successfully by irrigation for five years. His well is 110 feet deep; has pump and iron turbine windmill, 10-foot wheel; has sufficient water for a large herd of cattle and to irrigate 1 acre in vegetables. He believes in irrigation from wells and in fruit raising, especially the grape.

We have in Martin County quite a number of wells not mentioned in the foregoing; notably one on section 4, township 1 south, block 37, 8 miles west of Marienfeld. It is 6 feet deep. It has a chain-and-bucket pump capable of furnishing 5,000 gallons of water per hour. It is inexhaustible. Pumps by 1 horse-power. This pump was kept going fourteen hours in August, 1889, at a round-up, when it supplied water for eight thousand head of cattle. This well belongs to C. C. Slaughter, of Dallas, Tex. He also has a similar well in Mustang Draw, 18 miles northwest of Marienfeld. This well is 12 feet deep. Along Mustang Draw are five or six more wells from 10 to 15 feet deep that are considered inexhaustible. C. C. Slaughter has three wells on Sulphur Draw, at a place called Soda Springs, which wells are from 8 to 12 feet deep and inexhaustible. They are supplied with pumps and windmills and the water is secured in troughs for watering cattle. Soda Springs is 21 miles north of Marienfeld, in Martin County.

The first witness from Gaines County, Tex, was W. A. Quebedeaux. He lives about 100 miles northwest of Marienfeld. He has one well 30 feet deep, with a pump and 12 foot "Star" windmill. With a 4-inch cylinder and 2-inch pipe his well will supply and does supply seven hundred head of cattle. He says he has an earth tank 50 by 60 feet, which holds water without any protection except a strong wire fence to keep cattle out. Has stood for three years and is good for all time. Out of this tank he draws water into troughs for his cattle as fast as they need it. His windmill runs day and night and keeps large tank full. He does not farm.

The next witness from Gaines County was George Bell; he lives about 110 miles northwest of Marienfeld. Has three wells—one dug well 27 feet deep and one 40 feet deep. One bored well 51-feet deep. Has one "Star" 12-foot windmill, and one 10-foot iron turbine mill. They throw about 15 gallons of water per minute. Both dug wells are inexhaustible. He can not say anything about bored wells because he has not tried them yet. Can find an abundance of water anywhere in his vicinity by sinking a well. He never farmed any. Thinks this is a very good country for all kinds of fruit, but especially the grape.

Joseph Arnold, the next witness, lives also in Gaines County, about 100 miles northwest of Marienfeld. He has four dug wells, supplied with one 12-foot "Star" windmill and three 10-foot iron turbines. His wells are about 40 feet deep, and furnish about 10 gallons of water per minute each. Has one dirt tank about 200 feet in circumference, 6 feet deep. The earth is thrown up and a rough stone wall is built around it on the outside. His windmills pump water into this earth tank and he lets it run in troughs for the cattle to drink. He says earth tanks are a success in his vicinity. Never raised fruit; raised sorghum without irrigation in 1888, but it was too dry for it this season. His wells are inexhaustible. From these last three witnesses it was learned that the following wells are in Gaines County, Tex.:

On Mallet ranch there are twelve dug wells from 9 to 45 feet deep, mostly supplied with iron turbine windmills. Two of them have 16-foot "Eclipse" windmills. There are also on this ranch eight or ten earth tanks—the ground excavated and thrown up outside, and then fenced to keep cattle out. These tanks give perfect satisfaction. These wells are inexhaustible. In making them, when water is reached the manager puts a strong pump with 5-inch cylinder into the well to keep the water out as much as possible, so as to allow the workmen to sink the well as deep as possible. Mr. Hardgrove has three dug wells from 9 to 40 feet deep. He has one 10-foot "Halladay" and one 12-foot "Star" windmill. Joseph Campbell has two wells 30 feet deep. Has one iron turbine and one "Star." A. F. Crowley has two wells; both are open wells and inexhaustible. Lighe Estes has six good open wells, or dug wells, and windmills. J. Arneson has one well—"Star" mill. The cost of digging wells is about $2 a foot; boring, $1 a foot. In sinking wells about 18 inches of flint-rock is met. The balance is earth and sand-stone. Another witness, Mr. T. C. Estes, could not say positively whether he lives in Texas or in New Mexico, the line not being well established. He has a well 34 feet deep furnishing an abundance of water for his flock of sheep. He never found any rocks in digging. Mr. James Smith, of Five Wells Ranch, lives about 40 miles northwest of Marienfeld. There are eight wells and seven wind-mills on this ranch. One well is 15 feet deep; two are 45; the others from 50 to 60 feet deep. These latter seven are bored wells. The 15-foot open well furnishes water for one thousand five hundred head of cattle; the others have a capacity for five hundred head. They use five "Star," one "Eclipse," and *one "Kirkwood"* wind-mill and wooden troughs.

sending this report now it is impossible to secure the opinion of the Rev. P. A. :s, of Marienfeld, he being absent. The secretary, N. S. Schmitz, desires to say im that the reverend gentleman has always considered the Staked Plains country ›est fruit, and especially grape, producing country in America. Four years ago er Peters had about one-half acre planted in grapes, from which he made quite of wine last year. In 1889, out of this half acre, he made 174 gallons of wine, h connoisseurs claim to be equal to any they ever tasted. I have visited the vine- of Father Peters several times this summer, once in company with a gentleman from France, who, when told these grapes had never been manured, told me that ıe champagne district near Epernay, where the finest of wines were produced, grape does not make such vigorous growth nor bear fruit so young. Mr. is, of Waco, Tex., a native of Sicily, Italy, who visited this vineyard also this ner, thinks this part of Texas excels every other country in grapes. Father rs owns section 14, township 1 south, block 36. He has one well and pump, ıted by a 14-foot "Challenge" mill. While he is the first who planted grapes, so raises large quantities of vegetables by irrigation from his 98-foot-deep well. arms extensively, and if his field crops do not yield so abundantly, owing to dry ners, he has absolute faith in the country whenever irrigation is applied.

to soil, topography, and rain-fall.—Martin County and the attached counties of es, Joacum, and Terry are on the so-called Staked Plains or Llano Estacado. soil is mostly a chocolate-colored loam and red sandy land, both of great depth fertility. The Staked Plains are an eleveted plateau, with an altitude of from) to 3,000 feet, extending about 125 miles east and west and 200 miles north and h. They are bounded on the west by the Pecos River and on the other three by a ledge of steep, rocky bluffs, from 50 to 100 feet high, and often of much ter elevation, and it seems from the abrupt and rugged outlines that this plateau ›een lifted up by some convulsion of nature. From the top of these bluffs, form- he boundaries, stretches out an undulating plain of surpassing beauty, covered a variety of rich grasses and traversed by long and gentle swells and depres- , strongly resembling those of the sea when settling down after a storm. This ›rmity of surface, however, is broken at rare intervals by deeper depressions, so- d draws, which look like a river bed. Water, there is none, but it can be ob- d in all these draws within from 5 to 15 feet from the surface. In order to trate how this land lays, I will say that a railroad could be built over this Staked 1 100 miles long without either cut or fill, and still I do not believe there are 40 : of land in one body that are perfectly level.

e rain-fall this year, if well distributed, would have been sufficient for all kinds ops. There was plenty of moisture in the ground all winter for plowing; we good strong rains also, early in spring up to March 1.

e following table gives amount of rain-fall to date. Since May I measured it in vernment gauge supplied to me by the Signal Service as its voluntary observer ie point.

Date.	How ascertained.	Inches.	Date.	How ascertained.	Inches.
3.....	Approximated	1.50	June 18.....	Gauged	0.04
.....	....do	1.00	June 21.....	....do.....	0.63
1	....do	0.30	June 29.....	....do.....	0.05
0	....do	0.50	July 2	....do.....	0.23
2	....do	0.10	July 6	....do.....	0.04
3	....do	0.10	July 7	....do.....	0.14
0–21	....do	1.50	July 8	....do.....	1.02
1	Gauged.....	0.49	July 9	....do.....	1.60
2	....	trace.	July 10	....do.....	0.04
3	Gauged.....	0.09	July 11	....do.....	0.05
6	....do	0.23	Aug. 10	....do.....	0.04
8	....	trace.	Aug. 11	....do.....	0.05
3.....	Gauged.....	0.01	September 14–15	....do.....	1.54
5.....	....do	0.21	September 15.....	....do.....	0.14
9.....	....do	0.48	September 17.....	....	trace.
10.....	....do	0.20	September 21.....	Gauged	0.08
11.....	....do	1.20	September 25.....	....do.....	0.06
16.....	....do	0.28	September 27–28	....do.....	1.01

RECAPITULATION.

ıary	Approximated	1.50	July.....	Ganged.....	3.12
ı.....	....do	1.30	August	....do.....	0.09
.....	... do	2.20	September to 28th ..	... do.....	2.83
.....	Gauged	0.81			
.....	....do	3.10	Total.....	....	14.95

STATEMENT OF GEORGE M. SWINK, OF ESTACADO.

IN RELATION TO THE PANHANDLE REGION.

The population of Crosby County is 600; that of Floyd, Dickens, and Motley Counties about 300 each; Garza, 100; Lubbock about 100. Surface of all these counties gently undulating prairies; soils principally dark sandy loams without exception fertile; grasses, mesquite predominates, some buffalo grass and abundance of hay grasses in the depressions. Altitude about 3,200 to 3,500 feet above sea level. Crops generally grown without irrigation are sorghum, millet, and forage, generally melons, garden truck, and vegetables of all descriptions. Several young orchards have been planted and some trees bore this year. Wild grapes, plums, and currants grow profusely along the breaks or cañons formed on the heads of the various water courses, generally tributaries of the Brazos River. Prospects for orchards on the open plain are excellent, and Mr. A. W. Lewis, near Estacado, has shown his faith by planting 80,000 young forest trees. His first orchard, consisting of peaches, pears, and apples, has borne an excellent crop this year, the flavor of the fruit being superior to that of any other part of Texas. This orchard is from five to six years old. Other orchards have been planted in the vicinity of Estacado by Messrs. Dr. William Hunt, Dr. W. V. Marshburn, Isaiah Cox, W. C. Dockum, Andrew Underhill, and others.

The neighborhood was settled in 1880, and known generally in Texas as the Quaker Colony. Since its settlement there has been enough rain-fall for all forage crops, though in some years the crop has fallen short, owing to delayed or too limited rain-fall. It is generally the opinion of the people residing there that the rain-fall is increasing. As everywhere else in western Texas, there have been times where one good watering of a crop by irrigation could have been of great benefit. For purposes of irrigation there are very few water-courses that could be utilized, for the reason that the amount of running water is very limited, and secondly, that the next arable lands are somewhat remote from these water-courses. Some of these water-courses lie from 100 to 300 feet lower than the level of the lands to be irrigated; but if the capital could be secured to construct dams across these water-courses they could be made to hold back water extending from 10 to 20 miles back from the dam in a comparatively narrow channel. The land that could then be brought under irrigation would amount to thousands of acres on each side. The question of damming these water-courses, all of which carry large volumes of water during part of the year, presents no great engineering difficulty, the question being merely a matter of dollars and cents.

The principal drainage of the Plains country is in basins or depressions in the soil, some of which contain water during the entire year, others from six to nine months in the year. Many of them could be made absolutely water-tight, and nearly all could be used for irrigation by use of pumps or windmills and storage-reservoirs placed on the higher-lying land under cultivation. It would be simply a question of raising and storing the water. By applying the different means of irrigation available about nine-tenths of the lands in the county of Crosby could be cultivated by irrigation, and the same could be said of most of the adjoining counties.

At Epworth, Hale County, Mr. Alex. Jones has a large garden under irrigation from a well and a 12-foot windmill. The benefit derived from irrigation is shown in his crop, which brought him more cash money for garden vegetables than all the other gardeners have been able to obtain for their joint crops.

Water in wells is obtained in all parts where dug or bored for. The average depth is about 75 feet. In digging wells from 4 to 10 feet of soil are encountered, then generally red or dark colored clay 20 to 25 feet. Next usually water is found resting on limestone. This layer of water is not very abundant. Going through soft limestone a hard limestone is met with, then sandstone, and then water in the greatest abundance is obtained. It appears that this second water is part of an underground lake or river. No well in the second water has ever been known to be exhausted when used either for ranch or domestic purposes. In many places water in abundance is found at a depth of 40 to 50 feet. For the irrigation of small orchards and vineyards there is no question but that water can be had in abundance. By the proper use of 12 to 16 foot windmills and small storage-tanks from 12 to 13 acres could be placed under irrigation. The principal business of the country consists of stock-raising and wool-growing; but it is the opinion of the people that a farmer so situated that he could have some live stock, raise forage and food products without irrigation, and carry on a garden of 3 or 5 acres under irrigation, ought to do well in Crosby and any of the adjoining counties.

STATEMENT OF J. E. LUCE, OF CISCO, EASTLAND COUNTY.

There is probably about one-half of the land under cultivation in this county. The thrashers report this year for the county an average of a little over 20 bushels of wheat per acre. Owing to a want of rain-fall at the proper time the oat crop was cut short to about 20 bushels per acre, whilst with rain at the proper season the average would probably have equaled that of 1888, which was from 65 to 70 bushels per acre. The corn crop this year will probably average 35 bushels per acre, whilst with rain at the proper season it would have made 50 bushels per acre. If frost does not come too early our cotton crop will average about one-half bale per acre, whilst with the proper rain-fall this county would have yielded three-fourths of a bale per acre. The apples, pears, peaches, etc., which should mature during dog-days, are usually cut short for want of rain, and the later varieties are inferior to what they otherwise would be in consequence thereof.

It therefore follows that our farmers are in great need of water for their crops during July and August, and in some years a demand for water is imperative at a much earlier season. The rain-fall will probably average about 33 inches, and if properly distributed would be sufficient. I think the topographical engineer's report for this county will give the best locations for storing water. Of course, as Cisco is the largest town in the county, a deposit of water near that town would accommodate more people than at any other one point. From Cisco to the south and southwest line of Eastland County wells are usually got at from 3 to 40 feet, whilst north of Cisco to the north line of said county wells are rarely secured except at great depth, yet there are exceptions. There are also some springs.

There is no one irrigating in this county at present. We think that at many places dams can be built, with a 2-inch pipe extending through them, and a faucet in the end thereof, which can be used to advantage, and the water drawn off by pipes or ditches to the places required.

STATEMENT OF GEORGE BAUER, BIG SPRINGS, HOWARD COUNTY.

I have at present about three thousand fruit and shade trees, consisting of apple, peach, pear, plum, apricot, nectarine, cherry, quince, fig, and almond; also grape-vines, blackberry, gooseberry, raspberry bushes. I commenced to plant my first trees in 1886 and 1887; about eight hundred fruit and shade trees. The drought destroyed most all of them, and those that were left were so stunted as to prove worthless. If I had had facilities to irrigate, I would have saved most all of the trees. During the fall of 1887 to 1888 I replanted with six hundred trees. During the drought of 1888 I lost four hundred. Discouraged with such poor success, I still gave tree-planting another trial in the season of 1888–'89. This time I set out two thousand five hundred trees. Through the best of culture and the best rainy season we had for years in west Texas I lost but few. I am now preparing to irrigate the coming season, for I can not rely on the natural rain-fall, and if a drought comes next season I will lose all of my trees. Had I been prepared to irrigate I would now have over one thousand fruit-bearing trees, instead of a few, every tree bringing an income of $2 per tree.

The soil and climate of this region are unsurpassed and adapted to produce the best of fruit, and of crops equal to California through proper irrigation, especially for fruit and garden crops for the Northern market.

For irrigation there are two means to be adopted: One is by damming the ravines to impound the rain-fall for use in the droughty season.

Nature has arranged this county for such reservoir irrigation. The other plan is to irrigate on a smaller scale; that is, through tanks and wells. Water is found at from 20 to 250 feet deep. Windmills are generally used for pumping. The cost of such a system for wells and tank would be about from $2,000 to $5,000, according to locality. Fully one-third of Howard County could be thus irrigated. The same would be correct for counties west of here. Irrigation would in a few years populate our present unsettled plains with a thriving population.

The Government, by establishing experimental stations for irrigation throughout the Southwest and West, would soon demonstrate the certain success of irrigation. Private capital would then develop this almost unknown region. Being close to the borders of Mexico, for political as well as commercial reasons this part of the United States should be developed and settled as rapidly as possible by the Anglo-Saxon race. Thousands of acres of fine lands can be reclaimed by irrigation to make homes for families, friendship will be strengthened, and commerce increased in both Republics.

STATEMENT OF W. J. MALTBY, OF BAIRD, CALLAHAN COUNTY.

The topography of this county is undulating.

There are estimated to be 16,000 acres in cultivation.

The yield in wheat is from 15 to 35 bushels per acre; in corn, from 25 to to 50 bushels per acre. Oats yield from 40 to 100 bushels per acre; cotton, from one-half to three-fourths of a bale per acre; all kinds of grasses, as far as tried, from 2 to 3 tons per acre, including millet, Johnson grass, and sorghum.

The value of these crops for the past year in this county is estimated at $200,000, including vegetables and hay products.

The annual rain-fall is 30.3 inches. The rain-fall for the months of January, February, March, and April, as well as November and December, is 1.50 inches.

March, June, and October are the months (and September) in which irrigation would be the most beneficial, as that would insure both a season for planting and fruitage of the crop.

There are about three hundred wells in the county, ranging in depth from 10 to 50 feet; average depth, 20 feet; usual cost, $1 per foot.

Sorghum, millet, and Johnson grass will grow without much water.

All the crops grown in this county would be doubled if water could be had on them at the proper seasons.

No artesian wells have ever been bored in this county, but the general opinion prevails that water for irrigating purposes can be obtained in all the valleys in the county at a depth ranging from 600 to 2,000 feet, and there is not a valley in the county that if irrigated but would more than double its yield of agricultural products. These valleys are numerous and are all so situated as that dams could be constructed and a large acreage irrigated in this way. The outlay to construct a few dams at various points need not be necessarily great, as the material for their construction is found in abundant quantities in all our hills adjacent to these valleys. If the proper season could be put in the earth at the proper time, there is no part of the United States that would surpass these valleys in the production of fruits and vegetables. Apples, peaches, pears, plums, and grapes all do well, especially the peach, pear, and grape, which as produced here are the finest flavored in the world.

If a few artesian wells could be obtained in this county by which the question of artesian water would be made certain individual enterprise would then do the rest, and our county would teem with population well-supported, for the products of this section will support a greater population than any other section, and it is the healthiest country known. Near the geographical center of the county, and just north of the divide of the waters of the Brazos and Colorado Rivers, an artesian well can be sunk which, if a success—and there is every reason to believe it would be—a vast body of land would be made almost in a garden, as it could and would all be put in cultivation. This I have had in my mind for years, and if artesian water can be obtained at this point, then not only in this county upon the north of this divide, but in all the adjacent counties, the question would be solved, except as to the depth, which would of course vary, owing to the altitude of the point where the well would be made.

STATEMENT OF C. H. EARNEST, OF COLORADO.

First, with respect to the topography of Mitchell County: The extreme eastern and northwestern portion of the county is high table-land, with a soil almost approaching black waxy, perfectly level, except where modified by basins or slight depressions in the general surface, in which water stands for a considerable portion of the year after once filled by rain-fall. This character of ground is limited within the bounds of Mitchell County, the most of this table-land being in Nolan County, to the eastward. West of this table-land begin the breaks or ravines which form the headwaters of Lone Wolf Creek and North and South Champlin Creeks. These streams flow southwestwardly to about the center and south of the center of the county, where they empty into the Colorado River. They are not running streams, except for a very short period after rains. They do however furnish an immense volume of water when it rains because of the large area drained by them.

The Colorado River runs clear through the county from northwest to southeast, being a running stream the year round, except for perhaps a month during a very dry season. It does not then cease running, but only loses itself in places here and there where the bed of the stream is sand.

West of Colorado River are the following streams flowing into the Colorado River and situate partially or entirely within Mitchell County, to wit: Willow Creek, *Morgan,* Wild Horse, Camp Creek, Beal's Creek, Hackberry, Dugout, and Rendrebrook. *On the* east side of the Colorado and in the southeastern portion of the

county we omitted to mention Silver Creek, which is a running stream the greater portion of the year. The same may be said of Deep Creek, which rises in Scurry County and empties into the Colorado River about 3 miles within Mitchell County from the north line.

Reverting to the country west of the Colorado River, this is divided into table lands between the creeks and valleys along the creeks. Some of these valleys are as much as 2 to 3 miles wide, notably that of Morgan Creek. The soil of the Morgan Creek country is a red clay. Experience has shown that it is very fertile for the production of general crops, and will easily hold water in tank building. In the Rendrebrook, Beal's Creek, and Hackberry country the divides or intervening prairies are black or dark chocolate soils and very rich. Rendrebrook and Hackberry Creeks are furnished by springs at the head of each, furnishing a regular stream the year round, of four to five inches of water.

For irrigation we would think Hackberry preferable to Rendrebrook spring from the fact that the valleys of the former are greater in extent than those of the latter.

Second. Number of wells in the county. So far there must be as many as ninety to one hundred wells. The average depth is 100 feet. The wells around the town of Colorado are generally about 100 feet (from 75 to 100), the water rising in them from 30 to 60 feet. The shallowest wells are in the northern and eastern portions of the county. We know of no well in the county which, being as deep as 90 or 100 feet, can be pumped dry by a 12-foot windmill running forty-eight hours under a full head of wind. In the western portion of the county it is deepest to a good flow of water.

At the city water-works, 1½ miles east of the business portion of the town, are two wells, only one of which is used and operated by a windmill—a 30-foot mill. The lessees of the works, Messrs. Fletcher & Caldwell, inform me that the water can not be exhausted by a constant use of this mill for any length of time. The only way in which it can be lowered at all is by attaching an engine, and they estimate the flow of either of these wells to be one hundred and forty gallons each to the minute. These wells are 190-foot bored wells.

Since the leasing of the works by Messrs. Fletcher & Caldwell they erected a 30-foot mill over one well, and during their lease of more than eighteen months they have not had to use their steam-engine as much as three weeks altogether, and they furnish the water supply for a city of 3,000 inhabitants.

This stream of water was found in boring for salt by the new salt company at the same depth, and it is believed that at the depth of 190 to 200 feet it can be found anywhere east of the Colorado River.

The salt wells, of course, are as deep as 940 feet. After striking salt they went this deep to get ample water. Mr. Blount, of the Lone Star Salt Works, tells me that their steam-engine pumping day and night has never lowered their salt well.

This volume of water, it will be remembered, is below the bed of salt and can be cased off. The stream of water at 200 feet and less is above the bed of salt, and is good water. The cost per foot of bored wells is now 75 cents per foot for the first hundred feet, and perhaps $1 or $1.25 per foot for the next hundred.

Third. No one here is farming strictly by irrigation. Several are gardening, fruit and grape growing by irrigation from shallow wells. Among them are C. H. Lasky, J. F. Clayton, A. M. K. Sowell, Mr. Wrigsell, Victor Dziedzioch, Fred. Schroder, H. C. Townsend, J. D. Martin, A. R. Earnest, H. A. Fowlkes, J. W. Holmes, W. H. Hughes, Durham Wulfjin, Ben Van Tuyl, H. B. Smoot, C. H. Earnest, and others. It is estimated that to irrigate 5 to 10 acres of fruit trees or grape vines, or both, the cost of fixtures complete would be not less than $1,000 for surface irrigation, the same as is used so far in this country. Irrigation by underground perforated tiling would add to the cost, but would very much increase the area to be covered perhaps twice or three times.

For the year 1889 there was no material difference between fruits irrigated and those not irrigated. But this has been a specially good seasonable year. Ordinarily the difference is remarkable where they are irrigated and well cultivated as well.

Fourth. The crops that will do well every year in this county without irrigation are sorghum and the ordinary forage crops and cotton. Three years out of five corn (Indian corn) will do well without irrigation; so also will potatoes, melons, etc.

Our irrigated fruits are superior to the fruits of central Texas, far superior in flavor, and are equal, if not superior, to the irrigated fruits of California. This statement is made from actual comparison of fruits raised this year in Mitchell County with those raised in central Texas, and upon the strength of statements of Californians who are here and who resided for a number of years in California. Our grapes are equal to the California grapes, and all varieties have been given a thorough test except the El Paso or Mission grape variety. The test as to this is limited but very satisfactory.

Mr. W. S. Marshall thinks that by using a 30-foot mill pumping water from a 200-foot well, with a tank constructed after the manner of the reservoir at the works of the Texas Salt Company (lined with pitch and tar), and with perforated tiling or some other cheap means of distribution of the water without waste, that 30 to 50 acres of fruit trees or grape vines could be irrigated to advantage.

As to whether the Colorado River or other streams in the county could be utilized by dams or storage tanks for profitable irrigation is a question which could be best answered by some one more familiar with irrigation. A rich area of country could be reached by any of these streams with a head of water far enough up to reach our upland prairies, and it would seem the plan would be a practicable one.

STATEMENT OF MARSHALL H. D. W. SMITH, JR., ASSISTANT ENGINEER OF THE TEXAS AND PACIFIC RAILWAY.

I would say that the most important streams on the Rio Grande division for irrigating purposes are the Brazos, the Colorado, and the Pecos Rivers. These are living streams, running at all seasons, and flowing through rich valleys susceptible of a high degree of cultivation if properly irrigated. The Brazos valley is accounted the best region in Texas for cotton and wheat, and is settling up rapidly throughout its entire length. The turgid waters of the Brazos hold in suspension vast quantities of rich detritus, which, if distributed over the adjoining lands, would greatly increase their fertility, and enhance the value of the riparian tracts especially.

The country along the Colorado River is as yet but sparsely stttled, being given up almost exclusively to the stockmen; but the rich chocolate loam of this section, particularly along the headwaters of the river, offer tempting inducements to the farmer. Here I have seen mesquite trees 30 inches in diameter, the normal growth of this tree rarely exceeding 10 inches. This in small tracts, where the water reached them by natural means.

So far as experience shows, the Pecos valley is very productive, and great hopes are entertained for its future. The Pioneer Canal Company, an incorporated institution, is now engaged in constructing a large irrigating ditch in this valley, which they will have in working order in the near future.

As to water from wells: Between Gomez and Arroyo flowing water impregnated with sulphur can be obtained at depths varying from 250 to 500 feet. Between Big Springs and Monahan's, where our road traverses the southern edge of the Staked Plains Plateau, a distance of about 100 miles, water can be found at 50 feet depth; though between Douro and Monahan's, 25 miles, the water is more or less saline. At Monahan's, however, where we have three shallow wells, the water is fresh and in unlimited supply.

The artesian well at Pecos is a strong flowing well, being 213 feet deep, and lifting the water to 30 feet above the surface by natural pressure; but we rarely use it for steaming purposes, owing to the presence of sulphur. We have at Toyah an abandoned artesian flowing well, 800 feet deep, useless for engines on account of its sulphur impregnation.

Our deep wells at Colorado and Van Horn, or wells elsewhere of similar depth, could not be made available for irrigating purposes, since the cost of raising water from such great depth would be so great as to preclude its use.

The San Martine Valley, around San Martine Station, enjoys an annual rain-fall unprecedented in western Texas. Two miles north of San Martine Tank water can be obtained at any time at a depth of 2 feet.

Two miles north of Carrizo Pass water can be found in great abundance at slight depths.

Antelope and Apache Springs, about 7 miles south of Kent Station, are large, bold springs, with a daily capacity of about 250,000 gallons.

Water stations of the Texas and Pacific Railway, Rio Grande Division.

Distance West from Fort Worth.	Name of station.	Source of supply.	Daily capacity.	Remarks.
Miles.			*Gallons.*	
0	Fort Worth ..	Artesian well and pond...	75,000	Steam pump, well 389 feet deep.
2.60	Clear Fork ...	Clear Fork Creek.....	Unlimited ..	Do.
20.13	Aledo	Three wells.....	40,000	Do.
30.65	Weatherford .	Well and siphon	18,000	Steam pump, well 43 feet deep; siphon from creek.
47.95	Rock Creek ..	Well and creek.....	Unlimited ..	Steam pump, well 41 feet deep.
55.21	Brazos.....	Palo Pinto Creek.....	....do	Steam pump.
79.43	Strawn	Well.....	50,000	Steam pump, well 31 feet deep.
84.25	Canyon.....	Palo Pinto Creek.....	Unlimited ..	Steam pump.
92.52	Tiffin	.....do	....do	Do.
98.57	Colony Fork..	Well and creek.....	6,500	Steam pump, well 65 feet deep; water from well, Colony Fork Creek, and, in very dry seasons, tank cars.
121.37	Delmar	Pond	Limited.....	Steam pump.
137.80	Baird.....	Mexia Creek	Unlimited ..	Do.
139.25	....do	Pond	Limited.....	Steam pump, pond one-half mile east of round house; capacity, 8,300,000 gallons.
146.68	Clyde.....	Two wells.....	10,000	Steam pump, wells 42 feet deep.
160.20	Abilene	Pond	Unlimited ..	Steam pump, pond formed by damming Cedar and Clear Creeks at their confluence.
178.20	Merkle	Well.....	40,000	Steam pump, well 48 feet deep.
199.74	Sweetwater ..	Sweetwater Creek.....	Unlimited ..	Steam pump, well also. Well was insufficient, and creek was dammed.
223.25	Lorraine.....	Well and pond.....	60,000	Steam pump, well 50 feet deep.
228.83	Colorado	Artesian well.....	24,000	Steam pump, well 143 feet deep.
237.92	Westbrook...	Pond	Limited.....	Steam pump.
253.99	Iatan	.....do	Unlimited ..	Do.
267.61	Big Springs ..	Spring.....	100,000	Steam pump, distance south from tank to spring, 11,880 feet.
288.39	Marienfeld ...	Well.....	24,000	Steam pump, well 72 feet deep.
304.62	Midland	.....do	60,000	Steam pump, well 32 feet deep.
329.58	Odessa.....	.....do	50,000	Steam pump, well 47 feet deep.
362.96	Monahan's....	Three wells	200,000	Steam pump, wells 52 feet deep.
399.24	Pecos.....	Artesian well.....	60,000	Natural flow; sulphur water. Well 213 feet deep used in emergencies only.
419.83	Toyah.....	Tank cars from Monahan's	.....	Water in this vicinity strongly impregnated with sulphur.
443.46	San Martine..	Spring.....	8,000	Steam pump.
488.40	Van Horn	Four artesian wells.....	Unlimited ..	Steam pump, 2 wells 600 feet deep; 1 well, 580 feet, and 1 well 550 feet deep.
521.99	Sierra Blanca.	Tank cars from Van Horn.	.....	Southern Pacific Railway has artesian well here 930 feet deep; water slightly brackish. Maximum daily capacity about 24,000 gallons. Texas and Pacific Railway is now (October, 1889) sinking one here.

Principal streams crossed by Texas and Pacific Railway, Rio Grande division, with distances west of Fort Worth, in miles.

Stream.	Miles.	Stream.	Miles.
Clear Fork of Trinity River	2.61	North Fork Palo Pinto Creek	83.30
Do	20.18	Do	83.76
South Fork of Trinity River	20.41	Do	84.30
Do	21.28	Do	84.61
Do	26.93	Do	85.26
Do	27.80	Do	87.20
Do	28.09	Do	88.86
Do	28.67	Palo Pinto Creek (viaduct)	90.76
Do	30.11	Clear Fork of Brazos River	163.04
Do	30.60	Champlin's Creek	223.30
South Branch Clear Fork of Trinity River	32.59	Lone Wolf Creek	229.78
Do	33.57	Colorado River	230.37
Brazos River	54.55	Morgan Creek	235.04
Palo Pinto Creek	59.09	Pecos River	398.26
South Fork Palo Pinto Creek	77.70		

Water stations supplied from streams alone	6
Water stations supplied from wells alone	11
Water stations supplied from ponds alone	5
Water stations supplied from two or more sources	5
Water stations supplied from springs alone	2
Water stations supplied from tank-cars	2
Total number of water stations, Rio Grande division, this date (October 22, 1889)	31

THE KANSAS DIVISION.

ON TRAIN, NEAR DODGE CITY, KANS., *September* 11, 1889.

The committee met pursuant to the call of the chairman. Present: Mr. Stewart (chairman) and Mr. Jones; also Director Powell.

STATEMENT OF EDWARD D. TAYLOR, OF KINGSLEY.

The CHAIRMAN. Where do you reside and what is your occupation?

Mr. TAYLOR. I reside in Kingsley, Kans., and I am superintendent of public instruction of the county of Edwards.

The CHAIRMAN. Do you have any difficulty in raising crops in this vicinity for want of moisture?

Mr. TAYLOR. Yes.

The CHAIRMAN. How often do you raise a full crop here if you depend entirely on rain-fall?

Mr. TAYLOR. We have raised but two full crops since I have been in this western country—that is, in twelve years. We have only partial crops nearly every year.

The CHAIRMAN. Can you raise partial crops at all times—vegetables, fruit, and grains?

Mr. TAYLOR. We raise partial crops of grain and corn nearly every year, but we need irrigation for full crops. Apples and cherries will give a full crop without irrigation, but peaches freeze.

The CHAIRMAN. What are the means of irrigation?

Mr. TAYLOR. The Arkansas River is the only means we have in this neighborhood. There is a small creek here, called Coon Creek, that gives a little water.

The CHAIRMAN. How wide is the Arkansas valley—the low valley—before you get to the hills?

Mr. TAYLOR. On the north that valley runs 25 miles. On the south there are sand-hills near the river.

The CHAIRMAN. To what depth do you require to sink for water in this valley.

Mr. TAYLOR. On an average 40 feet. On the divide they have to go some 200 feet.

The CHAIRMAN. Are there some places less than 40?

Mr. TAYLOR. Some 20 and some 60.

The CHAIRMAN. In what formation do you find the water?

Mr. TAYLOR. In quicksand.

The CHAIRMAN. Does that extend all over the valley?

Mr. TAYLOR. Everywhere.

The CHAIRMAN. What do you say as to the quantity of water where you do reach it?

Mr. TAYLOR. There is more than could be exhausted by any ordinary pump. In one well we put in a steam-pump and it did not get down over 4 feet, when they got 400 gallons of water a minute; but the en-

gine could not pump that more than one or two minutes; consequently they could not exhaust the well with that engine.

The CHAIRMAN. How much land could be irrigated with a single well with a good pump?

Mr. TAYLOR. I could not say of my own knowledge. The pump I speak of was such an absolute failure that they did not try to irrigate with it. It was said they could have irrigated 80 acres with that pump.

The CHAIRMAN. At what expense?

Mr. TAYLOR. I could not say as to that.

The CHAIRMAN. When you go back from the valley proper what is the character of the country in western Kansas?

Mr. TAYLOR. It is a rolling prairie.

The CHAIRMAN. Have you ever examined the rolling prairie with reference to the storage of water in ravines?

Mr. TAYLOR. Not with special knowledge in that respect, but I know there could be water stored in the ravines. I have seen ravines where men in wagons would be drowned during the time of the rains. The ravines could not be forded.

The CHAIRMAN. Does the rain fall in violent showers during the season?

Mr. TAYLOR. Nearly always in violent showers.

The CHAIRMAN. At what time do the showers prevail?

Mr. TAYLOR. In July and August; sometimes earlier; sometimes in March or April.

The CHAIRMAN. If you saved the water then would that be early enough for the irrigation of crops?

Mr. TAYLOR. Not unless there was rain-fall or snow during the winter to start the crops; that rain would not be early enough.

The CHAIRMAN. If you had plenty of water how early would you plant corn?

Mr. TAYLOR. In May or June.

The CHAIRMAN. Then water in July or August would help you?

Mr. TAYLOR. Yes.

The CHAIRMAN. How late could you plant potatoes if you had water?

Mr. TAYLOR. At the same time as other vegetables. These rains come usually in July and August, and they are too far apart then.

The CHAIRMAN. But if that water were stored you could do something with it?

Mr. TAYLOR. Yes.

The CHAIRMAN. Have any of the people who attempted to farm here left because they could not raise regular crops?

Mr. TAYLOR. Yes; many.

The CHAIRMAN. As to the town of Kingsley, has anybody left that on account of the drought?

Mr. TAYLOR. Yes.

The CHAIRMAN. How many?

Mr. TAYLOR. I presume five hundred.

The CHAIRMAN. Do you know the exact longitude of this place?

Mr. TAYLOR. I do not. We are near the one hundredth meridian.

The CHAIRMAN. How is it farther east from here? Is there more rain than there is here.

Mr. TAYLOR. Somewhat. I only know by what men tell me. They have better crops than we have here.

The CHAIRMAN. How is it west of here?

Mr. TAYLOR. Worse.

Adjourned.

DODGE CITY, KANS., *September* 12, 1889.

The committee met at 7 p. m., pursuant to call of the chairman.
Present, Mr. Stewart (chairman).

STATEMENT OF J. W. GILBERT, OF DODGE CITY.

The CHAIRMAN. How long have you resided here, Mr. Gilbert?
Mr. GILBERT. In this county, nine years.
The CHAIRMAN. Is there sufficient rain-fall here to produce crops without artificial irrigation?
Mr. GILBERT. No, sir.
The CHAIRMAN. What kind of crops can you produce here without irrigation?
Mr. GILBERT. Nothing very successfully, except perhaps sorghum, and of that not a full crop.
The CHAIRMAN. You can not produce the various cereals and vegetables and fruits without irrigation.
Mr. GILBERT. Not successfully.
The CHAIRMAN. What crops can you produce with irrigation?
Mr. GILBERT. Anything adapted to this latitude.
The CHAIRMAN. With full success?
Mr. GILBERT. Yes.
The CHAIRMAN. With irrigation, how much wheat can you produce?
Mr. GILBERT. From 40 to 50 bushels an acre, at least.
The CHAIRMAN. And how much barley?
Mr. GILBERT. I could not answer that question intelligently. I do not know.
The CHAIRMAN. You have not tried it?
Mr. GILBERT. No.
The CHAIRMAN. How is it with oats?
Mr. GILBERT. You can produce with irrigation as full a crop of oats as is grown anywhere.
The CHAIRMAN. Can you produce fruits here with irrigation?
Mr. GILBERT. The very choicest quality of fruits.
The CHAIRMAN. Of all kinds adapted to this temperate region?
Mr. GILBERT. Yes.
The CHAIRMAN. How is it with vegetables of different kinds?
Mr. GILBERT. They grow very finely with irrigation.
The CHAIRMAN. You can not produce them without irrigation?
Mr. GILBERT. No, sir.
The CHAIRMAN. What are the opportunities to irrigate this portion of Kansas—what is your water supply?
Mr. GILBERT. The Arkansas River; but we have found since we have been operating canals here that we are liable to be short of water at the critical time that it is needed for irrigation.
The CHAIRMAN. There is no water in the river that will flow in your ditch at that time?
Mr. GILBERT. No.
The CHAIRMAN. When do you require water?
Mr. GILBERT. During June, July, and August.
The CHAIRMAN. How wide is the valley of the Arkansas proper here before you get to the rolling part?
Mr. GILBERT. I think it would average 5 miles.

The CHAIRMAN. How deep do you have to sink in the valley of the Arkansas to strike water?

Mr. GILBERT. About 4 or 5 feet; though on what they call the first bottom not so far as that.

The CHAIRMAN. On the second bottom, including the 5 or 6 miles wide that you spoke of, how would it be?

Mr. GILBERT. I think an average depth of 6 or 8 feet.

The CHAIRMAN. Suppose you went 10 miles wide, how deep would you have to sink?

Mr. GILBERT. It would depend somewhat on circumstances; probably you would have to go to a depth of 75 to 150 feet.

The CHAIRMAN. That is, when you get on the uplands on the divide?

Mr. GILBERT. Yes.

The CHAIRMAN. In the valley, is there a good supply of this water that you find under ground?

Mr. GILBERT. We think it is unlimited almost.

The CHAIRMAN. In what formation do you find it?

Mr. GILBERT. In sand.

The CHAIRMAN. You have not sunk through the sand to know how deep it is, have you?

Mr. GILBERT. We are doing that now.

The CHAIRMAN. Have you any idea how deep it is?

Mr. GILBERT. The sands runs from 6 to 12 feet in depth.

The CHAIRMAN. Do you believe there is an underground river flowing in this sand?

Mr. GILBERT. Yes.

The CHAIRMAN. That is, the water that passes down in the dry season all mainly under ground?

Mr. GILBERT. Yes; all of it to every appearance.

The CHAIRMAN. Have you tried the experiment of lifting that to the surface in any way?

Mr. GILBERT. No. We want to experiment by going below the bed of the river for our water supply aud then conducting it into reservoirs.

The CHAIRMAN. What is the fall of the river?

Mr. GILBERT. About 7 feet to the mile. That is about the general slope of the country.

The CHAIRMAN. Have you tried running a cut or tunnel at a less grade than the river, so that you could get a flow of water?

Mr. GILBERT. The canal we have in operation now has a fall of only 1½ feet to the mile.

The CHAIRMAN. I mean you have not run it into the ground to see whether you could intercept the flow of the water under ground?

Mr. GILBERT. No, sir; we have not undertaken that yet.

The CHAIRMAN. Do you line your ditch with anything to prevent seepage?

Mr. GILBERT. No, it is not necessary.

The CHAIRMAN. It is not necessary when you get it to the surface?

Mr. GILBERT. No.

The CHAIRMAN. But if you should make an underground cut, I suppose you would have to protect it?

Mr. GILBERT. It would not have to be protected until we should reach what we term a natural canal in the sediment.

The CHAIRMAN. In Texas they line them with tar and pitch.

Mr. GILBERT. I do not think that would be necessary here.

The CHAIRMAN. Have you tried pumping at all?

Mr. GILBERT. Not in canals. We are supplying the city here with water from a well. That well is 24 feet in diameter and about 10 feet in depth. We can pump from that well millions of gallons a day and not lower it at all. That proves to us very conclusively that a reservoir or well 40 feet in width and from a half mile to 1 mile in length, properly constructed, and with the water conducted from it properly, would supply water for a canal of almost any size.

The CHAIRMAN. And that you could convey by gravity onto the higher lands as you went along?

Mr. GILBERT. Yes; we would, for instance, go 10 feet below the bed of the river. With the fall that the river and the country has to the east, we would have to go perhaps 2 miles before reaching a natural canal. We would give the ditch a fall of 1½ feet to the mile, thereby gaining 5½ feet every mile we would go.

The CHAIRMAN. In that way you would get an underground flow?

Mr. GILBERT. Yes.

The CHAIRMAN. And the perfection with which you could take out the water would depend on your works, and how thorough you made them?

Mr. GILBERT. Yes.

The CHAIRMAN. Have you any means of estimating what extent of country you could irrigate with the waters of the Arkansas if you could intercept the underground flow?

Mr. GILBERT. We are undertaking to irrigate a territory that consists of about 800,000 acres, and we think we will be able to do it. The river makes a very large bend here, starting in at Dodge City and bending to the south at Speerville east of here, that would be 13 miles from the river. The ditch we now have in operation reaches the top of the divide a little north of here and runs along that divide from that point east, dividing the water between a net-work of creeks and this river. There is very nearly half a million acres in that net-work between the creeks and the river.

The CHAIRMAN. That would be all right for that amount of land. When you get away from the river bed, what is the topography of the country north, south, east, and west?

Mr. GILBERT. The topography is very smooth in the center of our divide, sloping to the east about 7 feet to the mile and sloping to the north and to the south about 16 feet to the mile. The draws that form the topography to the north and south are, as a rule, very even and rolling, not broken, making a very nice country.

The CHAIRMAN. By what means can the balance of the land be irrigated beyond what you can reach by your proposed ditch?

Mr. GILBERT. I do not know.

The CHAIRMAN. Did you ever consider the question of saving the storm waters in tanks or reservoirs?

Mr. GILBERT. I have thought of that; yes.

The CHAIRMAN. That is practiced in other parts of the world?

Mr. GILBERT. Yes.

The CHAIRMAN. What would be the opportunities here for that? Could ravines be found that could be dammed; does the topography furnish an opportunity for that?

Mr. GILBERT. Yes.

The CHAIRMAN. Have you plenty of creeks and "draws," as you call them, running through the country?

Mr. GILBERT. Yes.

The CHAIRMAN. At what season of the year do the storms come?

Mr. GILBERT. Our heaviest rains come during the middle of the summer. But they come with such a rush and come and go so quickly that we could not use them.

The CHAIRMAN. I understand that; but if you had means of storage you might utilize that water?

Mr. GILBERT. Possibly. I think, however, that if you take my proposition to irrigate 800,000 acres from the canals we have in contemplation and in actual operation, we could double that amount by taking the water from the river, as I suggest, to enlarge those systems, and, perhaps, put in canals. I think that could be done to better advantage, cheaper, and with more certainty, than by efforts to get an increase from other sources.

The CHAIRMAN. I am not talking about that now. Suppose you should exhaust the river, so far as Kansas is concerned, how much do you estimate you could irrigate with the river in the State of Kansas?

Mr. GILBERT. That I could not say. I could only give you an estimate of our territory.

The CHAIRMAN. From here down?

Mr. GILBERT. Yes.

The CHAIRMAN. How much from here down?

Mr. GILBERT. I would not be able to estimate that beyond what we have in contemplation.

The CHAIRMAN. You put that at 800,000 acres, and you said that perhaps more could be irrigated?

Mr. GILBERT. Yes. I think it might perhaps be extended to 1,500,000 acres. We could extend it back.

The CHAIRMAN. Suppose you could go on and exhaust the Arkansas River, how much would that irrigate—how much would it serve?

Mr. GILBERT. That is a pretty hard question to answer.

The CHAIRMAN. You have made some examination of the quantity of water. Of course you can not give it accurately, but I should like to have an estimate.

Mr. GILBERT. I think it would irrigate one-third of the State of Kansas.

The CHAIRMAN. One-third of the part requiring irrigation, you mean?

Mr. GILBERT. Yes, and that is about 40,000 square miles.

The CHAIRMAN. As to the other two-thirds that require irrigation, what opportunity would there be for storm storage?

Mr. GILBERT. I think there would be an excellent opportunity.

The CHAIRMAN. It is an open country, as I understand it, with draws, ravines, and divides?

Mr. GILBERT. Yes.

The CHAIRMAN. It is very similar to the other countries where they store water?

Mr. GILBERT. Yes.

The CHAIRMAN. There has been no examination of the country with a view to determine what could be done in that line?

Mr. GILBERT. Not that I know of.

The CHAIRMAN. What is the character of the soil away from the immediate river bottom, on those rolling lands where you would have to store water?

Mr. GILBERT. The opportunity is very good indeed. We have a reservoir north of us that covers an area of a little over 50 acres. It is 24 feet deep. That water will seep away and evaporate about 4 inches *a day.*

The CHAIRMAN. If the water falls during the summer, you would *not have to* retain it a long time before you use it?

Mr. GILBERT. No, it will go down seemingly for two or three days to the number of inches I spoke of, but not so much after that.

The CHAIRMAN. After the reservoir gets puddled, so to speak, it would probably not seep so much?

Mr. GILBERT. Probably not.

The CHAIRMAN. Did you puddle your reservoir at all?

Mr. GILBERT. Not at all. We did not do anything to prevent its seepage.

The CHAIRMAN. How long would you have to hold the storm water before you could use it? It falls right along in the summer, does it, usually?

Mr. GILBERT. Yes, usually, but perhaps there is more that falls in the spring. We always have good prospects for crops here, but we do not get rain enough at the proper time. Our heaviest rains come after the spring season.

The CHAIRMAN. Have there been any failures of persons who attempted to farm in this part of the country?

Mr. GILBERT. Yes.

The CHAIRMAN. Have any persons left it because they could not raise crops?

Mr. GILBERT. Yes.

The CHAIRMAN. Very many?

Mr. GILBERT. Yes.

The CHAIRMAN. How often do you have an exodus or period of departure from this part of the country?

Mr. GILBERT. There has been quite a general moving out twice since I have been here, that is, within a period of about nine years.

The CHAIRMAN. How many people went out from wetern Kansas?

Mr. GILBERT. I think about one-third of the population.

The CHAIRMAN. Each time?

Mr. GILBERT. Yes.

The CHAIRMAN. What became of those that remained?

Mr. GILBERT. They branched out into the stock business and different pursuits and managed to hang along until another favorable season came.

The CHAIRMAN. Is it practicable for a farmer to come here and make a living as a farmer without irrigation?

Mr. GILBERT. No, sir.

The CHAIRMAN. You meau that it is entirely impracticable?

Mr. GILBERT. Yes.

The CHAIRMAN. And every attempt has been a failure?

Mr. GILBERT. Yes.

The CHAIRMAN. And there have been two occasions since you have been here in the last nine years that a large portion of the population left?

Mr. GILBERT. Yes.

The CHAIRMAN. What made them come back again?

Mr. GILBERT. Some of them might thereby retain their land.

The CHAIRMAN. Did the same ones come back or did a new crop come?

Mr. GILBERT. Partly some of the old ones came, but a large majority, I think, would be new-comers.

The CHAIRMAN. Then they would get experience and leave?

Mr. GILBERT. That is about it.

The CHAIRMAN. State anything further that you think may be instructive to the committee.

Mr. GILBERT. As a reason why we are anxious to develop this reservoir system, I will say that the Kansas Water Works and Irrigation Company have invested about $1,000,000 in a canal here. We have a canal about 96 miles long, 45 feet wide, constructed to carry 5 feet of water. Our failure to get water from the river at two or three critical times this year has led us to investigate this matter of utilizing this underground water, and we think that if we could construct a reservoir at the head of our large ditch and the other ditches that we have in contemplation we could make a success. If we could demonstrate this fact and utilize this water that we know to be under the bed of the river, it would develop about 800,000 or 1,000,000 acres of land here that would be as choice as land anywhere. I wanted to speak of that in order to show you that we are in earnest about it.

The CHAIRMAN. In flood times there is an abundance of water, is there?

Mr. GILBERT. Yes.

The CHAIRMAN. Is there any way to divert that and hold it in reservoirs until you want to use it?

Mr. GILBERT. We might store it in reservoirs. We have about fifty reservoirs on the line of our canal that we could utilize to some extent. We have some reservoirs east of here. There are two that I think of now, natural reservoirs, that would cover an area of two or three sections of land each.

The CHAIRMAN. Are there no places above here where it could be stored and made into large lakes above your ditch?

Mr. GILBERT. Yes, that could be done.

The CHAIRMAN. In case you fail to get sufficient underground water, why would it not be a good plan to save these flood waters?

Mr. GILBERT. It would be a good idea, and that could be done to some extent.

STATEMENT OF M. W. SUTTON, OF DODGE CITY.

The CHAIRMAN. How long have you resided here?

Mr. SUTTON. Thirteen years.

The CHAIRMAN. Have you given any attention to the subject of irrigation and have you observed it here?

Mr. SUTTON. I have to a limited extent.

The CHAIRMAN. What do you say as to the capacity of raising crops without irrigation?

Mr. SUTTON. I say it is a failure.

The CHAIRMAN. Do you know of any person who has tried it and left the country?

Mr. SUTTON. I have lived here for the time stated and there have been two or three new crops of people that have come in here. Many of those who did come went away. For instance, in 1879 quite a good many people come into this Western country for perhaps two or three years before 1879. Then there came a season when they left, and they continued to leave up to the fall of 1880 or the spring of 1881. In 1882 new people commenced coming and continued to come. They rushed here in crowds and continued to do so until 1887. Now they are going back again, leaving the country quite largely. They came here, they saw the rich soils and the splendid climate, and they started in to plow and plant. Then the rains came in the spring and the crops grew *magnificently* on and up to, perhaps, the 1st of July, and then there *was no more rain*. The hot winds destroy the crops, as a rule. There

are some exceptions, but as a rule they destroy the crops. People always think the next year will be better and so try on and on two or three years and then give it up.

The CHAIRMAN. That is the condition in western Kansas, is it—west of a line drawn across what point?

Mr. SUTTON. At Great Bend, Kans., and the failure from Great Bend west seems to be in proportion to the rise of the country.

The CHAIRMAN. It commences failing about how far west of Great Bend?

Mr. SUTTON. Perhaps at Great Bend, I would say.

The CHAIRMAN. It commences then about the ninety-eighth degree?

Mr. SUTTON. But the farmers raise pretty good crops in Barton County almost every year.

The CHAIRMAN. Some irrigation would do them good there?

Mr. SUTTON. Yes.

The CHAIRMAN. But as you go west it grows worse?

Mr. SUTTON. Yes.

The CHAIRMAN. And west of Great Bend it needs irrigation to make it safe to try farming?

Mr. SUTTON. Yes.

The CHAIRMAN. You have observed this river when it was up, have you?

Mr. SUTTON. Yes.

The CHAIRMAN. What is the volume of water running in the river at flood times?

Mr. SUTTON. I have seen this river, to the best of my judgment, 15 feet deep. I may be too high, but it has been 12 anyhow. Am I too high, Mr. Wright?

Mr. WRIGHT. It does not rise so high on the banks, but the quicksands wash out in the middle. When it rises 3 or 4 feet it is 10 feet in the middle of the river.

The CHAIRMAN. It is a vast volume of water, is it?

Mr. SUTTON. Yes, it is a vast volume.

The CHAIRMAN. If you could store the flood waters above how much land could be irrigated in western Kansas?

Mr. SUTTON. I can not give the number of acres, but I believe the Arkansas River would water that third of the State which lies west of this line, where we commence to need irrigation.

The CHAIRMAN. That is, if you could save the flood waters; if you could save the water that flows down the river?

Mr. SUTTON. Yes, and I think it could be pretty much all saved.

The CHAIRMAN. What chance is there for making large reservoirs above? Are you familiar with the stream above?

Mr. SUTTON. I have observed it. A little west of us and above this place the streams are running from the west to the eastward; they are also 12 to 15 miles apart, and are generally dry. Between these streams there is a divide, and from the top of that divide to each stream there is a gentle decline of the land. At the head of these streams, as far as my observation has gone, there is an immense plateau of salt land, and I think that with very little cost all of these flood waters could be carried on to those plateaus and stored there, and then run down these divides between these streams during the seasons of the year when it is most needed.

The CHAIRMAN. Would a survey by competent engineers showing the most available places for these reservoirs, etc., be regarded as beneficial.

Mr. SUTTON. I think it would not only be regarded as beneficial, but I am satisfied that it would be a success.

The CHAIRMAN. That is what we are inquiring, to see whether it would not pay to make these surveys. Leaving out of consideration now the Arkansas River, and considering only the other two-thirds that can not be watered by the Arkansas, what is the opportunity to store water for them?

Mr. SUTTON. I am not sufficiently well acquainted with the topography of the whole country to know. After you pass north here 65 or 70 miles I have not been over the country and do not know. In the times here when there is water in the Arkansas River, unless it is very low, there is sufficient water for any use and all uses, and when there is no water in the river there is no water for any purpose.

There is another thing to which I might call your attention. The Arkansas River is on a divide. The town of Meade Center, some 45 miles south of us, is some 35 feet lower than we are. The town of Jetmore, somewhat north of us, is 340 feet lower than we are, which in my judgment makes the Arkansas River capable of watering all this country on either side if there is a sufficient amount of water.

The CHAIRMAN. With water, what is the character of the crop produced here.

Mr. SUTTON. The crop produced here by water is superabundant. It is wonderful. The soil is very fertile, and only needs rain to produce any crop that can be produced in this climate, and to produce it in abundance.

There is another thing I wish to say: I believe that the homestead law is based on the wrong idea. It should be based upon improvement and cultivation and not based upon residence alone. As the law now stands, a man comes out into this country, settles on the land, and builds a little sod cabin. With $50 or $100 of improvements he can not cultivate much. Therefore very little of the land is cultivated, and very little improvement is made. The country is covered with a little short Buffalo grass; that is a sickly vegetation, at its best, and three or four days of hot sun and dry weather will ripen it. The country is all just the same as though it were bare, and there is no vegetation to keep the air cool. The hot wind that blows over the crop is manufactured right near the crops. As you well know, a field of corn will be burned a rod or two into the crop and the balance will be nice and green. You take trees and plant them out on a piece of land 40 rods wide and they will make a little stunted growth. Break up 40 acres and plant them in the center of that 40-acre piece and they will make a fine growth. Now, if this law required a man to break up 140 acres, even if he did not cultivate it, it would cover the field with vegetation and there would be less hot wind. If you break a piece of prairie land, and can go away, you can see it miles off afterward by reason of its greenness, while all the land around it is parched and dry.

STATEMENT OF R. M. WRIGHT, OF DODGE CITY.

The CHAIRMAN. How long have you resided in this city?

Mr. WRIGHT. Twenty-two years.

The CHAIRMAN. Have you observed the efforts made to cultivate the soil in western Kansas without irrigation?

Mr. WRIGHT. Yes.

The CHAIRMAN. Have they been successful?

Mr. WRIGHT. They have not.

The CHAIRMAN. Describe the efforts you have made and whether people have remained or not as a consequence of those efforts?

Mr. WRIGHT. As these gentlemen have explained to you, two or three crops of immigrants have come to this country in the last twelve or fourteen years.

The CHAIRMAN. What do you mean by two or three crops of immigrants?

Mr. WRIGHT. What I mean by that is this: different batches of immigrants have come into the country and about half of them, after two or three years' trial, have left. Some stay a little longer than others; some have remained four or five years and have then gone away, and a new batch has come in. That has repeated itself, I think, three or four times since I have been here.

The CHAIRMAN. Is it possible to farm in this part of the country—the western part of Kansas—west of Great Bend, without irrigation?

Mr. WRIGHT. It is only partially possible. They raise a very sorry crop here without irrigation.

The CHAIRMAN. Can a family make a living on the ground by farming?

Mr. WRIGHT. Not one out of five, I should say. Rain comes in streaks, here. Some cultivate the soil a little better than others, perhaps, and a few have made money but they are rare exceptions.

The CHAIRMAN. The great improvements have failed?

Mr. WRIGHT. The great improvements have failed.

The CHAIRMAN. Have you taken into consideration the possibilities of irrigation for western Kansas?

Mr. WRIGHT. Yes.

The CHAIRMAN. Have you observed the river from year to year?

Mr. WRIGHT. Yes.

The CHAIRMAN. What are the dimensions during the flood season, for example in the spring of the year, or whenever the water is highest?

Mr. WRIGHT. This river will average three-eighths of a mile wide, and an average depth of 6 feet.

The CHAIRMAN. With what fall?

Mr. WRIGHT. Seven feet to the mile.

The CHAIRMAN. That gives it great velocity?

Mr. WRIGHT. Yes. It seems to have much greater velocity when the current is in it.

The CHAIRMAN. The current is very rapid?

Mr. WRIGHT. Very rapid, indeed. You can not ford it.

The CHAIRMAN. If the flood water could be stored, have you ever considered how much land it would cover in irrigating?

Mr. WRIGHT. No, sir; but it would cover an immense amount of land. There is a terrible flow of water down this river. For eight months in the year it is full, and has plenty of water for everybody and everything. In dry seasons, such as we have had for the past two years, there is no water at all; that is, for four months in the year, for the last two years.

The CHAIRMAN. It dries up entirely once in every five years?

Mr. WRIGHT. Yes.

The CHAIRMAN. Even before they took any water at all out above?

Mr. WRIGHT. Yes. It is, say from the middle of August to the middle of October. Whether they have any rain or snow at all, it seems that atmospheric pressure brings the water to the surface, and it commences to flow and flows freely as soon as the weather gets cool.

The CHAIRMAN. Perhaps that is owing to a diminution of the extreme evaporation.

Mr. WRIGHT. That may be so.

The CHAIRMAN. There is, also, I understand, an underground flow of water here?

Mr. WRIGHT. A very large underground flow.

The CHAIRMAN. How wide is that underground river, so to speak?

Mr. WRIGHT. I do not know; but I know that southeast of here, say 35 or 40 miles, it breaks out in very fine creeks. There is nothing in the world to produce that water and no place for it to come from, except from the Arkansas River.

The CHAIRMAN. If by any means that could be brought to the surface that would be of considerable aid, would it not?

Mr. WRIGHT. Yes.

The CHAIRMAN. Outside of the country that can be irrigated by the Arkansas River, in western Kansas, are you familiar with the topography of it?

Mr. WRIGHT. No, sir.

The CHAIRMAN. You have not been north and south?

Mr. WRIGHT. Yes, I have been north and south, but have never taken much notice of it.

The CHAIRMAN. Is it rolling here and there?

Mr. WRIGHT. Yes; there are many arroyos and creeks.

The CHAIRMAN. Could those arroyos be dammed and stored?

Mr WRIGHT. I suppose so.

The CHAIRMAN. You have not examined it with that view?

Mr. WRIGHT. No. The underground water I think is inexhaustible.

Mr. SUTTON (interrupting). For 35 or 50 miles on either side of the river, you have to go to the level of the river for digging wells. You can not tell how deep you have to go until you strike the sand.

Mr. WRIGHT. I will have to correct Mr. Sutton a little on that. You can dig a well (there is a well here) 300 or 400 feet from the river, and I venture to say that the water in that well is 4 feet higher than the water in the river. At different places as you go up the hill-side that increases.

The CHAIRMAN. You do not have to go clear down to the bed of the river?

Mr. WRIGHT. No. It rises considerably above the bed of the river. I think it is the flow from above that does that. It has the advantage of the flow of the river.

The CHAIRMAN. Still you think it comes from the river?

Mr. WRIGHT. Yes. Say, for instance, if it flows in at a half mile above, that would be 3 feet pressure from above.

Mr. SUTTON. That is, pressure from above in the manner of artesian water.

The CHAIRMAN. You have not stated what kind of crops you raise here?

Mr. WRIGHT. We raise a very good crop here under the ditch.

The CHAIRMAN. Describe it.

Mr. WRIGHT. It is a very good crop of corn, potatoes, and oats.

The CHAIRMAN. How much corn to the acre?

Mr. WRIGHT. I have not gathered it yet, but I expect 40 or 50 bushels.

The CHAIRMAN. How much oats?

Mr. WRIGHT. I think about 40 bushels. We did not get the water on the oats in time or we could get a good deal larger crop.

Mr. SUTTON. The reason of that was that there was not water in the *river, I suppose.*

Mr. WRIGHT. The potatoes are 60 bushels to the acre.

The CHAIRMAN. That is rather a small crop?

Mr. WRIGHT. Yes; but they are the best potatoes I ever ate in my life.

The CHAIRMAN. This land is rich, and will raise good crops if irrigated?

Mr. WRIGHT. Excellent.

The CHAIRMAN. What do you say of the climate?

Mr. WRIGHT. It is the best in the world.

The CHAIRMAN. Was there much suffering on the part of those people who had to move away?

Mr. WRIGHT. I can not deny that there was some little suffering, but our county has relieved many of them, and we would send them away sometimes when they could not get away from here themselves and could not do any more good.

The CHAIRMAN. How many times in the last twenty years have you had to help people out?

Mr. WRIGHT. I guess about three times. The Santa Fé Railroad Company issued passes at two different times, I believe.

The CHAIRMAN. To the people who wanted to get away who had attempted to farm here and failed?

Mr. WRIGHT. Yes.

STATEMENT OF JOHN W. SIDLOW, OF DODGE CITY.

The CHAIRMAN. How long have you resided in this vicinity?

Mr. SIDLOW. Fifteen years.

The CHAIRMAN. What do you say as to the efforts of settlers to make farms here, and as to their success or failure?

Mr. SIDLOW. The efforts have generally been a failure.

The CHAIRMAN. How many times have the immigrants tried it?

Mr. SIDLOW. There have been about three different attempts since I have been in the county.

The CHAIRMAN. Have large numbers come?

Mr. SIDLOW. Yes.

The CHAIRMAN. Throughout western Kansas?

Mr. SIDLOW. Throughout the western part of this State.

The CHAIRMAN. What became of them?

Mr. SIDLOW. I think in 1879 there were about two-thirds of the people who settled in the county and attempted to farm that had to leave.

The CHAIRMAN. What did the others do?

Mr. SIDLOW. Some of them came with some means and were able to worry through some of the poor years, expecting that the crops would be better, and there were two or three years in which the crops were very good—that is, they were fair; and it encouraged the farmers to put in largely of crops. Then there would come a dry season, and what they had accumulated in two or three years was all used up by the failure in one of those dry seasons.

The CHAIRMAN. And they had to go away?

Mr. SIDLOW. Yes.

The CHAIRMAN. Then there is no safety in farming in this vicinity except by irrigation?

Mr. SIDLOW. I do not think there is.

Adjourned.

GARDEN CITY, KANS., *September* 3, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), Plumb, and Jones of Arkansas; also Director Powell.

STATEMENT OF G. W. CONYERS, OF FINNEY COUNTY.

Senator PLUMB. Where do you reside, Mr. Conyers?

Mr. CONYERS. In the north part of Finney County.

Senator PLUMB. What is your occupation?

Mr. CONYERS. I am a farmer.

Senator PLUMB. Are there any ditches running through your part of the county?

Mr. CONYERS. Not through my part of it.

Senator PLUMB. How near are you to the nearest ditch?

Mr. CONYERS. About 5 miles to the nearest ditch that has ever had any water in it.

Senator PLUMB. What was the result of farming there without irrigation?

Mr. CONYERS. It was an entire failure.

Senator PLUMB. You could raise nothing?

Mr. CONYES. A little sorghum as feed for stock. That is the best we could do.

Senator PLUMB. You raised a little, but you can raise more?

Mr. CONYERS. Yes.

Senator PLUMB. Is there a sure crop up there?

Mr. CONYERS. Not a sure crop, by any means, without irrigation.

Senator PLUMB. Is any other crop a sure crop?

Mr. CONYERS. My experience is that rye is about as sure a crop as anything we can plant without water.

Senator PLUMB. How far is it to water?

Mr. CONYERS. About 20 feet.

Senator PLUMB. Have you a good supply?

Mr. CONYERS. We have an inexhaustible supply. I have a well bored with a 6-inch auger; I have a windmill on that well and have pumped 150 barrels of water a day from it; there seems to be no end to it.

Senator PLUMB. Have you tried irrigation by that means?

Mr. CONYERS. Yes; I have tried it from a tank in the garden, filled from that well.

Senator PLUMB How large a garden?

Mr. CONYERS. A small patch.

Senator PLUMB. Could you, by duplicating these appliances, extend the area of irrigation on that place?

Mr. CONYERS. Yes; if I had any means by which I could get the water out. There is water enough on my place to irrigate a whole quarter section.

Senator PLUMB. By "means" do you intend to signify some pumping appliances different from what you have?

Mr. CONYERS. Yes; I have not power enough to irrigate any special amount of land.

Senator PLUMB. Could you get it by duplicating or triplicating your *present* pumping plant, such as windmills?

Mr. CONYERS. Yes; but I have been farming so long without the security of irrigation that I have not the means now to get the appliances.

Senator PLUMB. Have you any suggestions to make as to anything that can be done in the line of testing the conditions necessary to secure irrigation in your locality?

Mr. CONYERS. No, sir; unless some plan could be arranged to elevate the water we have in the country up there. There is an abundance of water there to irrigate the whole country if we had some means of elevating it to the surface.

Senator PLUMB. You need only an ordinary pumping plant?

Mr. CONYERS. That is all; some power sufficient to raise the necessary amount of water.

Senator PLUMB. You consider it a settled fact, then, that there is a sufficient body of water within 20 or 25 feet of the surface?

Mr. CONYERS. I do. There is an ample supply there.

Senator PLUMB. To what extent has this underflow been determined by your neighbors or yourself—through what extent of country?

Mr. CONYERS. My place is 17 miles north of the river. I get my well water from the sand formation. When you go west some miles you get into land where they have to go 100 feet for water.

Senator PLUMB. Do you think you are on a level with the Arkansas River at that 20 feet?

Mr. CONYERS. I think so. I do not know that that is the case, however, having no way to determine, but my best judgment is that it would be on the exact level with the Arkansas River.

Senator PLUMB. Have you no suggestion to make, then, as to anything that would be necessary to determine by further tests the existence of this water and the means of getting it to the surface?

Mr. CONYERS. I think it could be tested here in this bottom or valley. The main thing that the people of this country want, I think, is to have it demonstrated that there is a supply of water here.

Senator PLUMB. That has been demonstrated on your place, you think, in your locality?

Mr. CONYERS. I think it has. I think if it was demonstrated that this water was supplied here in sufficient quantities capitalists would take hold of it and let us have a supply of water.

STATEMENT OF R. J. CLARK, OF GRAY COUNTY.

Senator PLUMB. Where do you reside?

Mr. CLARK. In the south part of Gray County, 50 miles southeast of here.

Senator PLUMB. How long have you resided there?

Mr. CLARK. Since 1884.

Senator PLUMB. Where did you come from?

Mr. CLARK. Directly from Illinois.

Senator PLUMB. State in your own way what is in your mind concerning this question that we have been discussing as to that which, in your judgment, can be done in the way of irrigation and how to meet the situation in your county.

Mr. CLARK. What can be done and how I do not know, but something must be done if this population is to be kept here. I came here in 1884, as I say. In 1887 we had a voting population of 1,500 men in our county. Some of those came for the purpose of speculation, a small number of them to prove up their claims, mortgage them, and make all

the money they could and leave. A large proportion came here, however, to settle and with the determination to stay in this country. They have staid: First, they exhausted their own means to come here; secondly, it became necessary to mortgage their land; they did so; that money went in trying to hold up and improve this country; thirdly, the wants of their families compelled them to mortgage their stock. I am in such situation that I know for a fact that three-fourths of the personal property in Gray County to-day is under chattel mortgage, and that the mortgage money is gone.

Senator PLUMB. We want to know generally the situation down there.

Mr. CLARK. We have held up this country by publication in the papers. We have held it up until the people are ruined. Now, it is becoming necessary for the facts to be made known, let it be to the Government or whoever it may be.

Senator PLUMB. The question before us is as to the needs of the country, and what those needs are. In regard to the condition of things that would make agriculture highly profitable—that is another question.

Mr. CLARK. We have endeavored to hold up this section as a part of the State you represent, Senator. Now, it becomes necessary that you, as our representative, should know the true character of this region, so that you may report it as you hear it.

Senator PLUMB. Just state it in your own way. How long has it been since your people came to the conclusion that the natural precipitation of moisture would not do for crop purposes?

Mr. CLARK. We had been thinking that for two years.

Senator PLUMB. Upon what was the judgment of your people originally based that there would be sufficient precipitation of moisture?

Mr. CLARK. We had nothing to base our judgment upon. We came into this country. The beauty of it is unsurpassed, and the fertility of the soil, on thorough examination, with the applied moisture then found, proved to us that the richness of this soil also was unsurpassed. All we needed was moisture, and we hoped that there would always be sufficient rain-fall to produce crops. Up to the present time we have found sufficient to produce all crops except perhaps in April and July.

Senator PLUMB. It is not properly distributed?

Mr. CLARK. That is the trouble. Through April we have a spell of dry weather that cripples the wheat and oats so that they never recover.

Senator PLUMB. What is the elevation of your county above the sea-level?

Mr. CLARK. I do not know that I can answer that question, but I think it is about 2,800 feet.

Senator PLUMB. How deep do you go for water?

Mr. CLARK. From 100 to 200 feet.

Senator PLUMB. What streams are in your county?

Mr. CLARK. Crooked Creek in the south, and the Arkansas River in the center of the county.

Senator PLUMB. Is there any water in the Arkansas River now?

Mr. CLARK. No, not flowing on the surface.

Senator PLUMB. What has been the condition of the stream for the last two years?

Mr. CLARK. We have usually had a flow of water in June and July. Last year the stream went dry, and this year it has also done so.

Senator PLUMB. What in your mind is the course to be pursued to

enable your people who are in the strait you have mentioned to maintain themselves where they are?

Mr. CLARK. I have only one fact to give. I live at present at Ingalls. Near that place is a dam, and the Eureka Canal goes out from there. That dam is very hard to hold. When the rush of water comes in the river it tears out the rock. The company conceived that they could dig a lateral from the main ditch below the dam, and, when the river is up high, they would let the water flow from the ditch and out into the river again. In digging that they had to dig from 4 to 6 feet deep, and they dug it in the southeasterly direction. The length of the ditch was nearly half a mile. When they got down to the level of the river they struck water. They kept scraping out the dirt until they came to water. The ditch is now dry. That went on, and they cleaned out that ditch to the river, and the water flowed out there through that lateral. It seemed to come up from the bottom and flow out through that. From that I gained an idea that by proper appliances—I do not know what they should be or how they should be constructed—but that by going into this river bottom at any point and excavating the earth perhaps 6 feet deep for a distance of 3 to 4 (or perhaps even 2) miles, whatever was necessary, you could get a constant flow of water out of this river at any point.

Senator PLUMB. In your judgment, would that be sufficient for all the adjacent country?

Mr. CLARK. I do not know how that would be.

Senator PLUMB. No estimates have been taken as to the flow?

Mr. CLARK. I am not mistaken as to the flow I have spoken of at Ingalls.

Senator PLUMB. But what I mean is that there have been no measurements as to what the extent of the flow is, or of the depth of the water?

Mr. CLARK. No.

Senator PLUMB. Have you any further suggestions to make about this matter? I should like to have you state just what has been in your mind as to the thing that could be done to meet the present emergency and also to meet future conditions.

Mr. CLARK. In Meade County, south perhaps 10 miles of where I live, they have flowing wells, fifteen or twenty, put down by private capital. Perhaps there might be flowing wells got all over Gray County. I do not know. There is no person there that has the means to put down those wells at the present time; their means are gone. The people in that section of the country are in a deplorable condition. If, perhaps, the Government should see fit to put down a flowing well I think that that would demonstrate the fact, and eastern capital might be brought in there and get wells.

Senator PLUMB. Do you know if the experiences had with the flowing wells referred to would warrant the expectation that if they were multiplied largely the flow would keep up? Has it done that so far?

Mr. CLARK. It has kept up; yes, fully. The largest well there has a 4-inch pipe. That well has been flowing since it was first sunk, and has been flowing full and with such force that when you take a bucket and hold it under it the power is so great that the water will overflow and you can only get a half bucketful from it. A gentleman has taken a large "draw" from it from which he has irrigated and grown trees; they are doing well. From that he has also flooded a field in which there are potatoes and all sorts of vegetables. In that field I can show you potatoes equal to any grown in Utah in size and flavor.

Senator PLUMB. Are those wells in the bottom?

Mr. CLARK. No, sir; they are up on the hill. The first well we got there was down on Crooked Creek. The other wells are scattered over that country.

Senator PLUMB. How deep are they?

Mr. CLARK. From 60 feet (that is the depth of the lowest well) to 150 feet, the deepest well.

Senator PLUMB. You could not get artesian wells in your county at that depth?

Mr. CLARK. No; our wells are, as I say, about 110 feet.

Senator PLUMB. Is there plenty of water in them?

Mr. CLARK. Yes.

Senator PLUMB. A very large quantity?

Mr. CLARK. Yes. You can not pump the wells dry after you get well into this stratum of sand. When you have gone down 3 feet into the sand, you can put all the appliances and pumps you please to it and you can not exhaust the water.

Senator PLUMB. Have you any further suggestions to make?

Mr. CLARK. Nothing, only that I should urge the matter of investigating our water supply strongly on the Government.

Senator PLUMB. Within what time must something be done by somebody to enable your people to remain?

Mr. CLARK. The men who are there now are anxious to stay. If they knew that the Government was going to take hold of the matter and demonstate the fact beyond question, so that this water may be raised to the surface, they would stay on, notwithstanding that their condition now is very bad.

Senator PLUMB. Could they stay three or four years if necessary to meet that condition; or perhaps two or three years?

Mr. CLARK. Well, I do not know whether they could stay so long or not, but they will stay until starvation drives them out.

Senator PLUMB. Of course, if the demonstration you speak of were made, and if one artesian well were got, within a few months we will say, the question would still remain as to the sinking of others and the obtaining of capital; and the further question—a very important one, however—as to whether the supply will keep on under the multiplication of the wells?

Mr. CLARK. I have no doubt whatever as to the supply of water. I think that if the Government took hold and sunk one well to demonstrate the fact, and then went to work to investigate the amount of water under this river (for we know that if the water is there it can be got out, and that it can be got out in quantities sufficient to wet this country thoroughly), why the people would stay. They will not have to stay very long. The east is now watching this committee. The people are watching this committee as you pass around. After you have gone and made your report to Congress, if that report is favorable, and Congress comes to the assistance of people here, they will feel certain that the Government is going to do something to demonstrate this great fact, and as soon as that fact is established people will come here from the east and buy these cheap lands. In that way many men that are here to-day between life and death will have an opportunity, if they wish, to let loose some of their land to those who have money. This country is settled up largely by old soldiers, men who have been to the front, and have done their duty by their country and the Government, and it looks now as if the Government should come to their aid and do its duty by them. I would like you to go into the country and see the *true condition of* things, not from my words, but from actual observa-

tion and sight. We have got through "painting" it, and we have got down to bed rock.

Senator JONES. You made a statement just now to the effect that people are hanging on here between life and death. I wish you would state in the first place how long you have lived in western Kansas?

Mr. CLARK. Since 1884.

Senator JONES. I wish you would explain to the committee (the other members may know all about it, I do not) how you first came here and how the other people first came here; what your information was, and what your experience was?

Mr. CLARK. This country was thoroughly advertised by railroad companies and land agents. In the first settlement this country was filled up by persons who had been in better circumstances and something had broken them down financially, or by an active set of young men who broke loose from their family relations and wanted to do something for themselves.

Senator JONES. About what time was it that that movement set in?

Mr. CLARK. It began in 1884 and continued until 1886. This country was all taken up from 1884 to 1886, or virtually so. A few pieces of land, perhaps, were left vacant, but only a few.

Senator JONES. Are the same people here now who came here then?

Mr. CLARK. Yes, to a large extent. Probably a majority remain.

Senator JONES. Has there been any material emigration from western Kansas by people who have come here and have abandoned their homes and left?

Mr. CLARK. In 1887 we had a voting population of 1,500 in our county. To-day the vote will run about 600. We had a class of people who came here merely for speculation. They came merely to take up this land, mortgage it, make all the money they could and go away. Those men went the first six months. The men who remained are the men who came here to make homes.

Senator JONES. I think you said that that was but a small percentage of the population?.

Mr. CLARK. Yes, it was.

Senator JONES. What has been the cause of the great emigration of the other class of people who came here?

Mr. CLARK. The want of sustenance. Men who came here with limited means staid two or three years and could not raise crops, and the consequence was that they had to get out.

Senator JONES. Failure of the crops was the cause?

Mr. CLARK. Yes; and that is what is now about to drive the remainder of the population out.

Senator JONES. How have the crops been this year in this section of country? You have had an unusual amount of rain-fall this year.

Mr. CLARK. Yes.

Senator JONES. Have you had enough for your crops?

Mr. CLARK. We had, if it had been properly distributed. Our rains did not set in until April, and the wheat and oats were ruined by drought. Some hundreds of acres of wheat were caught in the drought, and it did not get high enough to mow.

The CHAIRMAN. What was the condition of the river in April? Was it high or low?

Mr. CLARK. In April we had water, and again in July. There are ten months of the twelve that are good for crops here. It is in April and July that we get caught.

Senator JONES. Is that on account of a small rain-fall in April and July, or on account of the greater demand for water in April and July.

Mr. CLARK. It is on account of the lack of rain in July.

Senator JONES. You do not have so much in July as you need.

Mr. CLARK. No.

The CHAIRMAN. How was the river last July?

Mr. CLARK. Nearly dry. There came a flood in the river, however, on the 12th of July, and we were ruined on the 14th of July. The 14th, 15th, and 16th of July are the days that ruined us this year. If we had had ditches at that time and had the water held in reservoirs so that we could have used it at the proper time we would have been much better off. The hot winds do not come from Texas or from other places 20 miles south of us. They generate right here. If we have a local shower here, twenty-four hours afterward the buffalo-grass has become again green. But where the local showers have not fallen the hot winds come on. Where they have local rains at the proper time the crops are right; but the great area of this country that did not have local rains is entirely destroyed; winds blew over us and destroyed our crops, but did not affect the crops of people at places where they have local showers; nor did it affect the people where they had local irrigation. This demonstrated beyond all question of doubt that all we wanted was moisture.

Senator JONES. Were there any experiments in agriculture before 1884 that would justify the settlement of this country for agricultural purposes?

Mr. CLARK. There had been to a limited extent. We came in 1884 and we found that many claims had been taken by men that came in 1876, 1877, 1878, and 1879. A few of those men who came tried agriculture and moved out.

Senator JONES. They had failed?

Mr. CLARK. They had failed.

Senator JONES. On account of the failure of crops?

Mr. CLARK. Yes; on account of the failure of the crops. Those who staid and went into the cattle business were able to remain.

Senator JONES. Then these representations that induced this immigration in 1884, as I understand you, must have been knowingly exaggerated; people must have been willfully misled into thinking that this country was good for agriculture?

Mr. CLARK. I think they were, as far as the railroad interests were concerned.

Senator JONES. At what prices were those lands in this country sold by the railroads?

Mr. CLARK. Five and six dollars an acre.

Senator JONES. On what terms?

Mr. CLARK. On long terms.

Senator JONES. Was no portion paid down?

Mr. CLARK. Yes; a part of the money was paid down.

Senator JONES. And the balance on long time?

Mr. CLARK. Yes. The land agents who advertised the country were new comers here the same as ourselves, and their advertisements were, I think, based on honor. In passing over the country they saw what a beautiful country it was here. The man who would plant a little sod and put it under moisture, would be readily convinced of the richness of the soil. Those advertising men, therefore, I think believed it, and the railroad men may have believed the same thing, although they were *conversant with* the land long before that.

I have here a card that has been handed to me by a gentleman who, I suppose, was here in 1883 and 1884. On that card he says, "Large crops." I would like the gentleman to be called to the stand to explain that. I do not know anything about it.

STATEMENT OF J. H. KELLY, OF GRAY COUNTY.

Senator PLUMB. Where do you reside?

Mr. KELLY. In the southwest part of Gray County.

Senator PLUMB. Do you live near Mr. Clark?

Mr. KELLY. No.

Senator PLUMB. Where did you come from when you came to that country?

Mr. KELLY. I came from the southwestern part of Ohio into Kansas.

Senator PLUMB. You may make any statement to the committee which you think bears on this subject of water supply for your section of the State, as briefly as you reasonably can. I suppose there is no necessity for your re-stating what Mr. Clark has already stated about the condition of the people. Of course, we can not take time for every witness to repeat everything.

Senator JONES. If those statements are in his opinion correct, he may say so.

Senator PLUMB. Yes. Dou you believe that what Mr. Clark said is correct?

Mr. KELLY. Yes; I think Mr. Clark has stated the facts of the case; and I believe, also, there is ample water. It is essential for the settlers of western Kansas to have that water.

Senator PLUMB. Where is the water?

Mr. KELLY. I think the water is in the earth, sufficient of it.

Senator PLUMB. Where is it with reference to being obtained; is it under the surface of the land?

Mr. KELLY. It is under the surface; yes.

Senator PLUMB. At what depth?

Mr. KELLY. I have sunk a well 96 feet deep, and I find ample water at that depth. I find a basin of water that is running, I think, as swiftly as the Arkansas River.

Senator PLUMB. In the bottom of your well?

Mr. KELLY. Yes; at 96 feet deep. I am on an altitude that is high on the divide between the Arkansas and Cimarron Rivers. I have been there for some five years.

Senator PLUMB. You think that water could be had for this section of the country at the depth of your well?

Mr. KELLY. No, I think not. I think you would have to go deeper. I think there is water sufficient, however, provided the people of western Kansas could afford the machinery which it would take to bring that water to the surface.

Senator PLUMB. You think there must be an artesian supply?

Mr. KELLY. I think so.

Senator JONES. Is your well an artesian well?

Mr. KELLY. No. But southeast of me 35 miles is Artesian City, on Crooked Creek, with an ample supply of water.

Senator PLUMB. What depth do they have to go there to get water?

Mr. KELLY. Fifty-five feet is the shallowest well. There have been four or five wells sunk at Artesian City, and the pressure will run, I think, about 2 pounds to *the square* inch.

Senator PLUMB. How much land do they irrigate at Artesian City?

Mr. KELLY. This is the first season in which they have attempted to irrigate land to amount to anything.

Senator PLUMB. What quantity do they now irrigate?

Mr. KELLY. I can not say; but they have irrigated enough to convince the people that the supply of water is sufficient. They have reservoirs for the dry period. They have produced everything; potatoes, cabbage, corn, rye, wheat, etc., at Artesian City.

Senator PLUMB. Your suggestion, if I understand you, is that it should be demonstrated that there is or is not artesian water under the surface of your section of country?

Mr. KELLY. That is my idea exactly. I am confident that there is sufficient water if it can be brought to the surface, and in the present condition of the people they require water very much. My idea is that the water is sufficient, and if the Government will take the matter in hand and demonstrate the fact that there is a sufficiency of water by making an appropriation to sink one artesian well, it will be a great thing for my section of the county. We know that in the Arkansas Valley there is ample water, but to concentrate the people of western Kansas into the Arkansas Valley seems to me a little absurd. At the same time many of our people are satisfied that if we bore into this stratum I have spoken of, the water will be found ample. That would mean millions of dollars to western Kansas. When I struck my well I dug 96 feet deep and came to running water, running as swiftly as the Arkansas River, running right through the quicksand and pebbles. It seems to me that the Government might go to work and sink one or more experimental artesian wells. They woud only have to go moderately deep.

The CHAIRMAN. What means have you taken to get the water to the surface?

Mr. KELLY. No means.

The CHAIRMAN. How did you get it to the surface?

Mr. KELLY. By going deep enough.

The CHAIRMAN. But how did you get it up?

Mr. KELLY. By pumping; by means of a wind-mill.

The CHAIRMAN. How large a wind-mill?

Mr. KELLY. The cylinder is 14 inches by 4 inches.

The CHAIRMAN. How large across is your wind-mill?

Mr. KELLY. It has a 12-foot wheel.

The CHAIRMAN. What amount of water does it throw up?

Mr. KELLY. I have never estimated.

The CHAIRMAN. Have you ever tried to irrigate a garden with the water?

Mr. KELLY. We keep a little reservoir besides my tanks, for cattle and so on. I put in a day and a half's work with the scooper and plow, to dam a little ravine to hold the water, and ran the water into that reservoir and it has been there all summer.

The CHAIRMAN. You do not make any further use of it than to water the stock?

Mr. KELLY. Nothing else.

The CHAIRMAN. You have not thought of elevating the water by windmill, storing it, and cultivating some land with it?

Mr. KELLY. Yes; I have thought a good deal of it, but I have not put it into practice.

The CHAIRMAN. Do you think it practicable?

Mr. KELLY. I do not know whether it is or uot. I think it is practi-

cable to irrigate that way, but we would have to go deeper than my well to do it. We would have to go down deep enough to get pressure or "head" enough to get the water to flow. I do not think it is practicable to get machinery to throw its water up at all—either windmill or engine.

The CHAIRMAN. Have you studied the question to see what has been done elsewhere?

Mr. KELLY. No; I have not studied it out, but I know that the water supply is ample.

STATEMENT OF R. O. JAMES, OF STEVENS COUNTY.

Senator PLUMB. Where do you reside?

Mr. JAMES. In Stevens County.

Senator PLUMB. Where did you come from; from that county?

Mr. JAMES. I came from Indiana.

Senator PLUMB. What is your occupation?

Mr. JAMES. I am a banker. Our farming community is not represented to-day. We had not expected you here until the 20th of the month or it would have been represented.

Senator PLUMB. Have you heard the statement of Mr. Clark as to the condition of the people in Gray County?

Mr. JAMES. Yes; I heard that.

Senator PLUMB. To what extent does that compare with the condition of things in your county?

Mr. JAMES. It compares about equally with the condition of things in a portion of our county. There are some parties in our county that have made a good living until this year. The county has been settled only about four years and this past year has been the most difficult of the four.

Senator PLUMB. That is, the present season?

Mr. JAMES. Yes. Since the 12th of July it has been "rocky" there, to use a western word. The farmers of our county believe that it can be irrigated by artesian wells.

Senator PLUMB. Are there artesian wells in your county?

Mr. JAMES. No; because we have not gone deep enough. We find water there at from 50 to 150 feet deep. We have three wells in our town, two squares apart, that give water at 80 feet. The 12-foot wheels of these wells are on day and night and have no effect to lower the pressure. The windmill has no effect whatever on the waters in the wells.

Senator PLUMB. The farmers in your county who have done well down there, up to this year, have they had any irrigation to aid them?

Mr. JAMES. No.

Senator PLUMB. In what respect, then, are they better off than their neighbors?

Mr. JAMES. We have two classes of land—one we call buffalo sod, the other is a sandy loam. The parties living on the edge of the sand have been each year more successful because it retains moisture. Mr. Kunz, a man who was an old farmer in the East and took care of his crop and worked diligently, and Mr. Nash, another man who worked diligently, made quite a success of their farms.

Senator PLUMB. Have there been other farmers in your county that have been successful?

Mr. JAMES. Yes; there is another man who has been successful there in raising potatoes. He was on the edge of the sand.

Senator PLUMB. To what do you attribute their special success?

Mr. JAMES. They are, as I say, on the edge of the sand.

The CHAIRMAN. Is the sand lower ground than the other.

Mr. JAMES. No; higher if anything.

Senator PLUMB. The men, you say, who have been farming on the sand have done well?

Mr. JAMES. Not all of them. It is only in localities where there have been local rains. There are some men in the county who happen to have been in the local showers, who have had fair crops, while other men right near them have not had any.

Senator PLUMB. Then it is the question in the distribution of water that has made the difference?

Mr. JAMES. Yes. In the southern and eastern part of our county they are far ahead of the central, northern, or western. Last year we were far ahead of the southern. It seems to be as it happens.

Senator PLUMB. State what, according to your belief and that of your people, is within reach and necessary to make a secure water supply?

Mr. JAMES. Our people are all anxious to know if the Government will take steps to learn whether this water can be raised from below us for irrigation purposes. If the Government will test that, we think that private capital will come in. It is only a question of whether this is inexhaustible or not. Mr. B. E. Steely, of our town, has a well, and he claims that there are 225 feet of water in this well. It was dug and bored with a 2-inch auger. There is another gentleman 2 miles from town who has a well 240 feet deep, and has 70 feet of water standing in it all the time.

Senator PLUMB. Has that to be pumped up?

Mr. JAMES. There is a windmill running all the time; it fills his trough and it runs out.

Senator PLUMB. Is it the opinion of your people that that sort of thing will be enough for irrigation?

Mr. JAMES. It is their belief that it will afford great relief in that respect. Our belief is that the stratum of water will prove to be artesian.

Senator PLUMB. But you do not rely for this opinion of yours, as to the water supply, upon what has already been discovered; you think there is a vein below that is artesian?

Mr. JAMES. Yes; I think that the third stratum, probably at 1,000 or even 600 feet, will give us plenty of water. My opinion is that the stratum of water runs from east to west, and that it comes from the mountains. Whether it will be inexhaustible or not is a question, and that question we would like to have settled. I spoke of a few of our successful farmers. We have been in the rain-fall, but there have been many who have tried to be successful who have not been in the line of local rain-fall. Last year Stevens County supported itself and shipped some produce out; this year, if the people had all remained there, we could not have done it. If the people had all staid we could not have fed our cattle.

Senator JONES. I understood you at first to say that there were certain citizens, certain farmers, in your country that were prosperous; but I afterward thought that you qualified that statement by saying that there were some years when these farmers were prosperous and *others when they* were not—depending upon the rain-fall. How is that? *Are there some men* who have been uniformly a failure?

Mr. JAMES. It is changing around. Mr. Kuntz, south of town, the old gardener that I spoke of, has been there four years. The first year there was not much raised, because there were but few people in there until the spring, and there was not time to prepare, but Mr. Kuntz would plant his melons, potatoes, etc., and he told me yesterday that he had 9 acres of potatoes that he had planted back again that had not sprouted, and which he had planted back with the idea that there would be rains. Our July rains have been very short. Our August rains, until this year, have been suitable for some purposes.

Senator JONES. Are there any farmers in your county that have raised good crops of wheat this year?

Mr. JAMES. We have some gentlemen who can tell you more than I can. One old gentleman in the northwestern part of our county (Dr. Allen) said he raised 1,000 bushels of oats, rye, and wheat, but many have not been successful.

Senator PLUMB. One swallow does not make a summer. The fact that one man has not made a success this year proves nothing. My question is, has there been a farmer in your county who has uniformly made a good wheat crop since the land has been in cultivation?

Mr. JAMES. I do not think there is. It is a question in my mind whether the wheat crop has been thoroughly tried or not. The county west of ours has given a better trial than ours. Many of the farmers there do not seem to think that wheat will do well there, but many of them this year sowed more than has been sowed before. Last year one good flood over a good deal of land in our county would have made a successful crop. I do not believe that Indian corn would be the success that other kinds would be. All new countries have their ups and downs with regard to population. I have heard some men in other counties at one time say that they could not get away, and yet to-day they are the wealthiest farmers in the county.

The CHAIRMAN. With reference to the water you find by sinking wells—does that seem to be extensive?

Mr. JAMES. Yes, and we can not lower it by steam-pumps.

The CHAIRMAN. Have you ever considered the question of combining together and getting machinery of some kind?

Mr. JAMES. Yes, I believe that could be done to some extent, but whether the water is inexhaustible or not is what we would like to have tried.

The CHAIRMAN. In the particular stratum that you spoke of, do you think the water would be easily exhausted?

Mr. JAMES. I do not think it would.

The CHAIRMAN. Do you say you have considered the propriety of combining and getting water enough for a neighborhood by machinery?

Mr. JAMES. Yes; we have under consideration now a proposition to issue $15,000 of bonds for that purpose.

The CHAIRMAN. You want to get a $15,000 plant?

Mr. JAMES. The county, according to statute, has a right to donate $15,000 to any firm or corporation for that purpose.

The CHAIRMAN. How much will a wind-mill throw out?

Mr. JAMES. It is according to the wind and according to the wheel and many things of that kind. I do not know that I could say just what quantity of water it would throw out in twenty-four hours.

The CHAIRMAN. Have you people tried to save the water thrown out by wind-mills for the purpose of irrigating gardens?

Mr. JAMES. No. Mr. Cook, north of the town, has a fish-pond. To fill that he tells me that he pumps two days and stops pumping one.

The CHAIRMAN. He has not tried making a garden of 2 or 3 acres?

Mr. JAMES. No. Mr. Kuntz, last year, did irrigate a little garden. Our county has no river in it, although the Cimarron River touches us on the border. Its altitude is higher than ours and when there is water there there could be an irrigating ditch made.

The CHAIRMAN. Has it ever occurred to you to dam up the ravines and save the storm water?

Mr. JAMES. Yes. That is a good thought, but it has never been tried. Water can not be held successfully, however, on sandy land, although it can be on the Buffalo land.

The CHAIRMAN. The idea has occurred to you that you might save water for small irrigation purposes from the storm storage?

Mr. JAMES Yes, and if the water under the Cimarron is sufficient we could get enough. The water in the river itself is not sufficient for much. I am satisfied that we have water under us sufficient to irrigate 30 acres of every 160. That would be sufficient. I know men in our county that would give 1 acre of land to have another acre irrigated.

Senator PLUMB. I have no doubt that there is water there. It is only a question of getting it to the surface.

Mr. JAMES. I have thought that the putting down of one artesian well in each county would be a great blessing to the people.

STATEMENT OF G. H. ALLEN, OF RICHVILLE.

Senator PLUMB. Where do you reside?

Mr. ALLEN. In Morton County, at Richville.

Senator PLUMB. How long have you lived there?

Mr. ALLEN. Nearly four years.

Senator PLUMB. Where did you go from?

Mr. ALLEN. From Cowley County, in this State. I am originally from Massachusetts, but I have been in this State for thirteen years.

Senator PLUMB. State to the committee in your own way and as briefly as you can the suggestions growing out of your experience or observation which bears on the question of water supply in this section?

Mr. ALLEN. As to this country as an agricultural country I am convinced in my own mind that with the exception of the want of water here it is one of the finest agricultural countries in the entire West. I believe that with the soil we have in southwestern Kansas all the features are here to make it a successful agricultural country if we can have sufficient water.

Senator JONES. What will be the result if you do not have water?

Mr. ALLEN. Then we can not mature crops. That has been the experience. In the spring months we have sometimes had rain enough to mature the crops, and up to the middle of June in this year we had fair prospects. Then the rain-fall began to diminish, and in July the crops were almost entirely destroyed by drought for the lack of rain to mature the crops.

Senator PLUMB. How was it with wheat?

Mr. ALLEN. That was cut earlier. It was cut principally in June, but it was damaged by lack of rain. There were some fields that were *pretty* good, however; one man told me the other day that he had an *average of 30* bushels per acre, and another had 21 bushels. These

were the best fields in the county, but there was a lack of rain to properly fill out the crop. All the indications point to this as a good wheat country. It has a soil that is fertile. It has all the elements existent in the soil to make it a good agricultural country.

Senator PLUMB. We all understand that all that is wanted in this country is water. Now, what do you have to state in regard to the water supply?

Mr. ALLEN. In our county a well was sunk that was six hundred and sixty odd feet in depth, flowing 23 to 24 gallons per minute, but that was insufficient for irrigation purposes. It is my opinion, however, and it is that of others, including Professor Hay, the State geologist, that the country is underlaid with artesian water, and that by going deeper a stronger flow could be obtained. We have demonstrated that there is artesian water there at a certain depth, and it is believed that by deeper sinking a stronger flow can be got, perhaps 2,000 feet. Our people would like to have the experiment made.

Senator PLUMB. Has there been more than one well sunk?

Mr. ALLEN. No. The city is about sinking another in the immediate locality.

Senator PLUMB. In what material is this water found?

Mr. ALLEN. It is really a red sandstone near the surface; down abont 200 feet it is a sort of quicksand.

Senator PLUMB. Has there been salt-water found?

Mr. ALLEN. There have been some indications of it.

Senator PLUMB. Would that be a good water for irrigation?

Mr. ALLEN. To some extent and for some purposes.

Senator PLUMB. State in your own way, and as briefly as possible, what you think is to be the source of the water supply there, and what you think the Government can do, from your own stand-point (without reference to what anybody else may think about it) to bring about that desired result.

Mr. ALLEN. The quickest means would be the sinking of artesian wells.

Senator PLUMB. You mean not for artesian wells in this flow that is already obtained, but for a lower flow?

Mr. ALLEN. Yes; for a stronger flow. The question whether artesian wells will furnish a permanent and sufficient supply is a mooted question and must be tested by actual experiment.

Senator PLUMB. Did Professor Hay, when there, say that there was a supply of salt-water, probably under the sandstone?

Mr. ALLEN. Yes; he said there would be probably salt-water there, but he did not say how much.

Senator PLUMB. If the water was impregnated as it is at Larned, for instance, would that be sufficient?

Mr. ALLEN. To a limited extent it would, but it is my opinion that it is not necessary to depend on that flow. I believe water would be found either below or above that salt-water at different depths to furnish artesian water sufficient for irrigation.

Senator PLUMB. You think there is another artesian stratum between the present flow and the salt-water below?

Mr. ALLEN. Yes.

Senator JONES. What do you base that opinion upon?

Mr. ALLEN. On the experiments in some other countries. It is stated that in some countries the first flow was never found to be so great as that below, and I furthermore base it on the opinion of Professor Hay, who is a good authority.

Senator PLUMB. Have you heard the statement of the condition of the people in Gray County as made by Mr. Clark?

Mr. ALLEN. Yes.

Senator PLUMB. To what extent does that correspond with the condition in your country?

Mr. ALLEN. The people of this country are depressed by bad crops in hard times, but I do not think that is a thing we should dwell upon.

Senator PLUMB. What has been the result of crops in your county for four years past?

Mr. ALLEN. Variable, more or less. Our best year for crops was our first year. That is three years ago; we raised more then than we have done since,

Senator PLUMB. Are there any differences growing out of the thoroughness of farming?

Mr. ALLEN. Yes.

Senator PLUMB. Some men do better than others?

Mr. ALLEN. Yes, I anticipate that will make some difference, but still we can not get along without more water. I think that an intelligent cultivation of the soil, coupled with the proper supply of water and at the proper time for cultivation, will make a great improvement. Our people are not all going to leave the country by any means. It is too good a country for that. We only want water at certain periods to help the growth of crops.

Senator PLUMB. Is there anything else that occurs to you?

Mr. ALLEN. I do not know that there is, except as to the manner of getting water from streams. In the valley of the Cimarron, which is a small stream, and is dry much of the year, there is plenty of water in the spring time. In the month of June this year we had an overflow of the stream there, and by tapping that stream several miles southwest water might be brought over the surface by ditches or aqueducts. The country gradually declines toward the east all the way from Colorado eastward. In our county the fall is about 20 feet per mile, so that the water could be easily carried. The country, however, practically is a level country. There are sufficient depressions to make local reservoirs of a small kind. However, those depressions and "draws" are usually of the lowest elevation below the surface of the country, and the work would be somewhat difficult, but there would be no difficulty in bringing water from farther west, in my opinion.

The CHAIRMAN. What do you think would be the depth you would have to sink to find surface water.

Mr. ALLEN. It varies from 40 or 50 to 100 or 150 feet.

Senator PLUMB. How abundantly do you find water when you strike it?

Mr. ALLEN. Quite abundant. We have not drawn on it for irrigating purposes in a way that would test its strength.

Senator PLUMB. Have you ever discussed the practicability of testing that and showing how much you had of it?

Mr. ALLEN. No; there has not been any direct discussion to settle that question, and of course all these questions have been touched more or less frequently and generally.

Senator PLUMB. Where do you suppose this supply comes from? Does it come from any river?

Mr. ALLEN. No; I do not think it takes its source from any river. It may be on the level of the Cimarron River, and the Cimarron River may be a part of that same flow.

Senator PLUMB. You say the Cimarron River had a good flow in *the summer once.* At what time was that?

Mr. ALLEN. I think about June.

Senator PLUMB. If you had had reservoirs would that have helped you considerably?

Mr. ALLEN. Yes; though if we had had reservoirs we could not have made them in our county; they would have to be farther west; but if we had the water stored above we could get it all over our county.

Senator PLUMB. Is it not possible, after all, that you could get a better supply of water that way than from any artesian well?

Mr. ALLEN. I will not say that; I do not know. I realize that that would take time to develop?

Senator PLUMB. What we want to know is the possibility of ultimately reaching that result.

Mr. ALLEN. Yes, I think there would be no question about that.

Senator PLUMB. You could supply considerable of the country in that way by damming up the tributaries of the Cimarron?

Mr. ALLEN. Yes, probably so.

Senator PLUMB. How wide a stream is it?

Mr. ALLEN. When it is pretty full it overflows its banks to the extent of half a mile wide, but the stream itself is not wide.

Senator PLUMB. We are talking about its flooding capacity.

Mr. ALLEN. In the spring time, when the snows are melting, there is usually a strong flow and the water overflows the banks of the river.

STATEMENT OF J. M. SLOAN, OF HAMILTON COUNTY.

Senator PLUMB. Where do you reside?

Mr. SLOAN. In Hamilton County, in the western part of this State.

Senator PLUMB. The Arkansas River cuts it through towards the center.

Mr. SLOAN. Yes.

Senator PLUMB. In what part of the county do you live?

Mr. SLOAN. In the central part; in the Arkansas Valley; at Syracuse.

Senator PLUMB. How long have you lived there?

Mr. SLOAN. Four years.

Senator PLUMB. Where are you from?

Mr. SLOAN. From Indiana.

Senator PLUMB. Please state the result of your observations in regard to the water supply of your locality.

Mr. SLOAN. We have two irrigating ditches under construction. The water supply of the river is nothing now, but it has never been that way before. There has never been a time before when a few ditches could not have been filled.

Senator PLUMB. What, in your judgment, is the reason for a diminution of the water supply in the river this year?

Mr. SLOAN. The lack of snow-fall in the mountains.

Senator PLUMB. You understand that during the last three winters there has been less snow than in any preceding year?

Mr. SLOAN. That has been my information. At the extreme western town of Coolidge they have artesian water 300 feet deep.

Senator PLUMB. In the valley?

Mr. SLOAN. Yes. We have tried it out of the valley, but can not get it.

Senator PLUMB. How deep do you go?

Mr. SLOAN. One thousand feet. We tried it out of the valley on the bluff. We struck several strata of water and there seemed to be no sufficient pressure in any of them. The water got up, but not to the surface.

Senator PLUMB. Was there a good volume of water?

Mr. SLOAN. Yes.

Senator PLUMB. Fresh water?

Mr. SLOAN. Yes, all good water.

Senator PLUMB. How far were you from the Arkansas River when you were at the side of this well?

Mr. SLOAN. About half a mile or three-quarters.

Senator PLUMB. Just off the bottom?

Mr. SLOAN. Yes; off the bottom within the town site.

Senator PLUMB. How high above the surface is the water at Coolidge?

Mr. SLOAN. Not very high. It runs about 20 gallons a minute.

Senator PLUMB. How many wells have they?

Mr. SLOAN. Two; then down 3 miles this side of Coolidge, on the other side of the river, they have another one which I have never seen, but I know it is an artesian well.

Senator PLUMB. With the same result?

Mr. SLOAN. Yes.

Senator PLUMB. State in your own way what your theory is about this matter of water supply for your county, judging, of course, from your observation.

Mr. SLOAN. I have no theory only the artesian theory. We would like to see that determined.

Senator PLUMB. You would like to see some wells sunk deeper, to see how far it would go?

Mr. SLOAN. Yes. We spent $7,000 on that well in our town and the digging of such wells to any extent is too expensive for our people.

Senator PLUMB. You did not try in the valley to strike a well such as they have at Coolidge?

Mr. SLOAN. No.

Senator PLUMB. Do you think that in ordinary seasons the ditches will have water enough?

Mr. SLOAN. Yes; if it was not for the law of Colorado forbidding ditches to come across the line, we would have large ditches. We have had a hard time here. The law of Colorado is that the water must be returned to the river before it crosses the line.

Senator PLUMB. You heard the statement of Mr. Clark in regard to the condition of the people in Gray County. To what extent does that correspond with the condition of the people in your county?

Mr. SLOAN. That is correct so far as concerns the men that depend on corn. The men that depend on stock get along fairly well.

Senator PLUMB. Cattle men get along very well?

Mr. SLOAN. Yes.

Senator PLUMB. But the men who depend on grain will want irrigation?

Mr. SLOAN. Yes; they must have irrigation.

Senator PLUMB. What forage plants have been tried here, and with what success?

Mr. SLOAN. Alfalfa where it has irrigation.

Senator PLUMB. But without irrigation?

Mr. SLOAN. Sorghum and millet.

Senator PLUMB. They have done pretty well without irrigation?

Mr. SLOAN. Yes; except this year.

Senator PLUMB. This year they all failed?
Mr. SLOAN. Yes.
Senator PLUMB. This year has been the worst in your experience?
Mr. SLOAN. Yes. Every year since 1884 they raised something. If the corn would not make grain it would make fodder.
The CHAIRMAN. Has your attention been called to the saving of the storm-waters?
Mr. SLOAN. Yes; we have thought of it.
The CHAIRMAN. Have any tanks been made in your part of the county?
Mr. SLOAN. Not to catch the rain-fall.
The CHAIRMAN. A good deal of water comes down that is wasted.
Mr. SLOAN. A good deal. The river flows past us many times when it is quite full.
The CHAIRMAN. And the small streams are also full very frequently?
Mr. SLOAN. Yes. One of those little streams will often flood a valley.
The CHAIRMAN. You have not considered the possibility of storing that water and flooding the land with it?
Mr. SLOAN. I have thought of it, but never saw it tried anywhere. There is a great deal of water coming down those streams and down this river; the water frequently washes the bridges away.
The CHAIRMAN. It is not necessary to make any experiments to demonstrate that that water is there?
Mr. SLOAN. No; the artesian water is there also.
The CHAIRMAN. But you do not know in what quantities the artesian water exists?
Mr. SLOAN. No; it is expensive to test it. It is only along the valleys in our county that it has been tested.

FURTHER STATEMENT OF R. O. JONES.

Mr. JONES. With reference to artesian water, while I think it would not be inexhaustible, and while I think there is plenty of it to do the irrigation that we need, I would say that last year at one time in our county one flood would have been all we needed. One flooding of the crops would have made a success of them. We had lots of crops during one time in the year, but the failure of water in July was very injurious. Had we had water at that time we would have had plenty of good crops. If we could irrigate as they do in California, where they have no rain at all for long periods, it might be that the artesian wells system might be regarded as not feasible. But we think it would be fair for the Government to try it.

FURTHER STATEMENT OF E. J. CLARK.

Mr. CLARK. I desire to add one word with regard to the artesian wells at Artesian City. Before they had artesian wells that country was covered wholly with buffalo grass. Since the location and flow of that well its constant stream and flow have killed out the buffalo grass, because that grass can not stand extreme moisture. Instead of the buffalo grass, there is to be found there to-day blue-stem or blue-joint grass standing 4 to 6 feet high.
Senator PLUMB. That will always occur where moisture increases. The buffalo grass gives way to blue-stem or blue-joint grass.

STATEMENT OF A. W. STUBBS, OF SANTA FÉ, HASKELL COUNTY.

Senator PLUMB. Where do you reside?

Mr. STUBBS. At Santa Fé, Haskell County, Kans., 28 miles south of here; I have lived there since May, 1888, and in Kansas about twenty-seven years.

Senator PLUMB. State the result of your observation as pertaining to the general subject of irrigation, especially in regard to the county in which you live.

Mr. STUBBS. We are exceedingly anxious to have more water. We believe that it is possible to obtain it from the Arkansas River. If it can be demonstrated that a flow of water can be got for irrigation from the river it would be a great blessing for our county. A survey has been made from our county to the Arkansas River, about Lamar, Colo. Water can be successfuly carried from the river all over our county, provided the supply is sufficient to warrant the construction of a ditch. What I should like to see, and what our people would like to see, is a demonstration of the fact that there is a sufficient supply of water in the river valley toward the construction of ditches.

Senator PLUMB. You are aware of the fact, as stated by a former witness, that the law of Colorado limits the flow of water found in that State to the uses of the people of that State?

Mr. STUBBS. That was stated, but it is a question in my mind whether it is true. Suppose a ditch should be constructed right up to the Colorado line and should be permitted to flow to that line, could that State forbid its flowing into Kansas?

Senator PLUMB. I am speaking about the law itself.

Mr. STUBBS. Well, then, does the law forbid it?

Senator PLUMB. That is my understanding of it.

Mr. STUBBS. And that is a question on which I am not posted.

Senator PLUMB. Is there any other supply that has come under your observation as available for that county?

Mr. STUBBS. There are artesian wells all around us, east, west, and southwest of us.

Senator PLUMB. Have your people experimented on that subject?

Mr. STUBBS. They have tried, but their means gave out and they have been unsuccessful.

Senator PLUMB. How far have they gone?

Mr. STUBBS. We have sunk a well 1,200 feet.

Senator PLUMB. Without finding water?

Mr. STUBBS. Without finding water that would rise to the surface.

Senator PLUMB. Did you find water?

Mr. STUBBS. We found some water at 200 feet and some at 400 feet with good pressure, and from there on we found water frequently, but without sufficient pressure to get to the surface.

Senator PLUMB. At what depth do you get ordinary well water?

Mr. STUBBS. It varies from 70 to 225 feet in our county.

Senator PLUMB. Is it very large at 225 feet?

Mr. STUBBS. Not very large at that depth.

Senator PLUMB. You do not get a large supply, then, until you get to about 400 feet?

Mr. STUBBS. No.

Senator PLUMB. And then it rises to 200 feet from the bottom?

Mr. STUBBS. Yes.

Senator BLUMB. Is it fresh water?

Mr. STUBBS. Very good, soft, fresh water.

Senator PLUMB. Has there been any survey or examination by scientific men which indicated that by going to a lower depth artesian water would be found?

Mr. STUBBS. No; there has not been, and we would very much like to have something of that kind done.

Senator PLUMB. What is the condition of farming in your county, and what, according to your observation, has been the condition of it since it has been settled?

Mr. STUBBS. We have some farmers, two or three in one locality, that have been successful, they tell me, every year in raising corn. With that exception I do not think that there is a township in our county that has been successful every year. The showers come as local showers. Last year it was very dry in the south part of the county, while there was plenty of rain in the north part to produce good crops. This year the eastern and central parts have been pretty well supplied with rains, while in our part it is very dry and some of the best farmers have had to leave the county because they could not raise enough even to feed their cattle.

Senator PLUMB. Have the storms been variable?

Mr. STUBBS. They have come in localities. I have been going back and forth to Haskell County since 1885, and have been watchful of the storms and made them a study. My observations are that the storms have flooded the streams. I have called attention frequently to the fact that when a cloud forms in the west, one rain-cloud comes down the Arkansas River and another goes down the Cimarron. They have had numerous rains when we had none on the divide.

Senator PLUMB. What have been the crops that your people have experimented with?

Mr. STUBBS. We have tried everything. I have made a special effort on my own farm. I have had thirty-two different things growing this year on my place. Some did well, such as Johnson grass, cattle corn, broom corn, and sorghum. I also raised pretty fair wheat this year. My corn is what you would call good here, but not what you would call good in eastern Kansas. It matured, however.

Senator PLUMB. Did you have millet?

Mr. STUBBS. Yes.

Senator PLUMB. Did that do well?

Mr. STUBBS. Yes.

Senator PLUMB. How did the precipitation of moisture in your county this year compare with the more favored parts of the section?

Mr. STUBBS. At Santa Fé we had as much rain as they had in any other part of the county.

Senator PLUMB. On the divide?

Mr. STUBBS. Yes.

Senator PLUMB. Then you think your part had the maximum of any part of the county?

Mr. STUBBS. Yes, I think so.

Senator PLUMB. You were at the experimental station yesterday and saw the cattle corn?

Mr. STUBBS. Yes.

Senator PLUMB. How did that compare with that grain raised in your county?

Mr. STUBBS. I have had corn just as good as that. We happened to have a rain that did not reach as far west in the county as where I live, and the winds that burnt others did not damage us.

Senator PLUMB. In your opinion do these hot winds originate locally, that is, do they originate near by?

Mr. STUBBS. I think they originate right on the ground. I have noticed them boiling up right in my face from the buffalo grass.

Senator PLUMB. You do not sympathize with the belief that they originate in Texas?

Mr. STUBBS. No. We have the largest body of smooth land in and adjoining Haskell County of any part of the United States. There may be on the Staked Plain a section that is somewhat similar. There is not a stream or even a ravine that could collect enough water for any irrigating purpose. The Cimarron rises about 1½ miles from the western end of our county, and with that exception there is no running water in the county during the year.

The CHAIRMAN. Is that in the western end of your county?

Mr. STUBBS. Yes. A survey has been made and a line run 100 miles west of us, and into Colorado, and the water has been taken out into a ditch in Colorado and brought across what they call the sand-hills. The water is on a high divide in Colorado, and the only thing necessary is to continue the ditch right into Kansas.

The CHAIRMAN. You do not think the law of Colorado ought to prevent the water from running?

Mr. STUBBS. I do not think it does. A man can not make a home in western Kansas and rely on rain-fall. Every man to-day in western Kansas is having a hard pull. Almost everything that he has is under mortgage, and it has been necessary for him to put it under mortgage in order to subsist.

The CHAIRMAN. Suppose that before that they had studied the best methods of getting water and devoted themselves to the subject, would they not have been in better condition to-day than they are?

Mr. STUBBS. Yes; I believe they would.

Senator JONES. If they had understood the conditions before they came here, would they come in such large numbers?

Mr. STUBBS. I doubt whether they would. We have a mixed population in Kansas; people from Dakota to Texas, and from Maine to California.

Senator JONES. It seems very clear that the people who came here to western Kansas did so without understanding the actual conditions.

Mr. STUBBS. The conditions at the time seemed to be such as to warrant their coming.

Senator JONES. Yes; but they were mistaken as to the actual conditions that existed.

Mr. STUBBS. Yes.

Senator PLUMB. Is there anything else that suggests itself to you?

Mr. STUBBS. Nothing else, except that I would like to see an appropriation made by the Government to determine the fact whether or not artesian water is available. Of course that is a question that we have no control over, but at the same time our people are anxious to have it tried. The parties who have bored our well are satisfied that the expenditure of some more money would result in finding more water.

Senator PLUMB. Is that well in such condition now as that, if additional funds were supplied, it could be deepened?

Mr. STUBBS. Yes. We have a thousand feet of 6-inch pipe standing there. There is a thousand feet of the well in good condition to start with.

Senator JONES. Have you no water in the thousand feet?

Mr. STUBBS. We have about 100 feet of water, but it does not flow

It rises from the bottom because the casing is solid. The dirt ks around the casing.
he CHAIRMAN. You cut off all streams down to the bottom?
[r. STUBBS. Yes; and we believe that in a lower stratum it would to the top. The wish may be father to the thought, but there are d indications to warrant the belief that that is true.

STATEMENT OF JOHN Q. A. NEWSOM, OF SCOTT CITY.

enator PLUMB. Where do you reside?
[r. NEWSOM. In Scott City, Scott County, which is the county ad- ing this to the north.
enator PLUMB. What is your occupation?
[r. NEWSOM. I am a farmer and an inventor.
enator PLUMB. What streams flow through Scott County?
[r. NEWSOM. We have no live streams, except the Beaver, in that nty.
enator PLUMB. State the conclusions at which you have arrived in ard to the chances of an artificial water supply in your county. I ume, of course, that you believe that artificial water supply to be nec- ary.
[r. NEWSOM. I do.
enator PLUMB. State the result of your observations as to the rces from which that supply must come, if it is to be had.
[r. NEWSOM. Having no live streams in the county we have to de- d upon the water supply from outside streams, such as the Arkan- River. We have a water-way in the county which is the bed of old stream that ran perhaps into an ancient lake. This lake is an delta, and that fills up this old stream. It is called the "White man." It runs through Scott, Wichita, and Greeley, into Colorado. rises in the eastern part of Colorado. It has water in our part of the nty only where there are heavy rains. I live in a basin. The Beaver stream which heads up near Greeley County, and runs into Gree- and Wichita Counties, and perhaps into Colorado also. The fount- of that stream seems to rise from water close to the surface, but the sion caused by the water has washed out cañons through Scott nty, so that it would be impossible to divert that water immediately Scott. I think that perhaps there is not enough water to pay for the uble of attempting to make it useful in Scott. As to the other stream- y it is doubtful whether there would be water enough there, unless same lay high enough so that it could be tapped by a horizontal educt, reaching into the water-line and conveying it down. I have investigated that question.
Where I live my well is 18 feet deep to the surface of water. I have pure water, at a temperature of 54 degrees, which is extremely cold that county. Our deep wells are warm and the shallow wells cold. impression is that if we could get water it would have to come from Arkansas River, unless we could construct a subterranean tap to water-line and bring it to the surface. That is a question I have investigated enough to give an intelligent opinion of what might be e. We need a water supply. As Mr. Stubbs has said, and as oth- have said, the people have left the county, and there is only a certain nber who can stay by raising stock. If engines could be had of great acity, higher up, that could raise the water a short distance to the sur- , it would settle the question. But whether the water could be applied

to public use or not, I do not know. A few farmers might join together and irrigate their land in that way, but when you contemplate a vast system of irrigation that should be beneficial to all people alike, and where all would be alike interested in it, it requires a more extensive system than is accessible to the people. If the Arkansas River has water enough, and aqueducts could be constructed to bring the water down, then we could get it into Scott County by canals, but the question is, Where shall we get the water? We have fine soil, rich in all the mineral constituents necessary to make fine crops, but it is lacking in the element of water, and in the vegetable elements.

Senator PLUMB. Is there a good crop of grass?

Mr. NEWSOM. An excellent crop of grass. In the locality in which I live there is what is called wild rye. There is periodical inundation of the basin in which I live, caused by the storms and head waters of the river. That makes a good growth of hay and some of the farmers in the locality have been able to raise a good crop of hay when the basin was flooded.

Senator PLUMB. Has there been any attempt to get artesian water?

Mr. NEWSOM. Not in our county.

Senator PLUMB. What is the source of supply, of which you speak, of the 18-foot well and similar wells in your neighborhood?

Mr. NEWSOM. The source of supply is sand, or clay, or lake-bed, or marl formation.

Senator PLUMB. Does it seem to be in a sheet of water?

Mr. NEWSOM. Yes.

Senator PLUMB. Is there a current to it?

Mr. NEWSOM. Yes, the current flows to the east. There is one feature about my well that I do not understand. It has been supposed by many people who lived in this section (the first settlers), that the water there was affected by the rise and fall of the water in the Arkansas River; I presume there are some who think that yet. My well is 14 inches lower now than when I moved there, two years ago last February, and I have thought that it was caused perhaps by the amount of water consumed in Colorado. I have asked other people about it, and I have not met with any one yet that has observed it in his own well, because the other wells are usually deeper than mine, and are usually covered up and can not be seen; whereas I can see exactly how much the water in my well varies. In the winter time my well will come back to the original point at which it was when I commenced; then, in February, again it falls. I take it that there must be some connection between our section and the Arkansas River.

Senator PLUMB. Do all the wells in your county reach up to the same level?

Mr. NEWSOM. I think they do.

Senator PLUMB. You think the deeper wells are at the same level?

Mr. NEWSOM. I think they are.

Senator PLUMB. While the water is warmer you think it is the same sheet of water?

Mr. NEWSOM. I think it is. The reason that the water is warmer I have attributed to the more rapid evaporation at the shallow depth and the slower evaporation in the lower depths. There are four degrees of difference in temperature between the water in my well and in the wells in other parts.

Senator PLUMB. If there is anything further that you wish to say about this matter we will be glad to have you state it as fully as you *wish. Give us* the results of your observation and the conclusions of *your mind.*

Mr. NEWSOM. I am very much interested in the success of the country and the prosperity of the people there. Every man of sympathetic feeling can not help being interested if he travels over that country and sees the amount of money that has been expended by those who have come to settle there in ignorance perhaps of the climate and of the conditions necessary to make homes. They evidently need some outside assistance in order to remain there. They have cast their lot there and all that they have is there. Any system that would bring that about would be a great blessing to those people.

There is one thing I would like to call the attention of the committee to. It is to a proposal—an extensive one—that has been discussed among our people, It may have been mentioned in your hearing. It is a proposition to irrigate from the Missouri River by striking it at one point in Dakota and bringing the water over the plains region here into the south. If that was a practical idea it would be a great enterprise for this country. If the lay of the country there is such that a large canal could take the water down it would be of great use here and would be of great use in the Missouri and Mississippi Valleys by preventing floods. We can utilize all the surplus water of these rivers and of the Yellowstone River that can be brought to us. It has been suggested that such a canal might be excavated and brought down. That would depend on the altitude and the fall that would be obtained in bringing it down. Your committee, of course, would understand whether that proposition would be worthy of entertainment.

Senator PLUMB. What has been the suggestion with regard to bringing the water across the other streams?

Mr. NEWSOM. There would have to be aqueducts constructed for that purpose. The question is whether it is a feasible proposition. Our people feel that it is. Our people feel that all the country between here and the Rocky Mountains could utilize that water in that way. The water could be utilized for manufacturing purposes also, when not needed for irrigation, by leading it into the Arkansas River, Smoky Hill River, the Republican River, Beaver River, and the streams that come out of the mountains. And you might carry it on to the Canadian River, the Cimarron River, and so clear on down to the Red River and the Staked Plains. Such a canal might be used also for moving heavy freights and might be made tributary to the deep-water outlets at the Gulf. I merely suggest this as a problem that comes under the scope of this investigation.

Senator PLUMB. Is there anything further that occurs to you?

Mr. NEWSOM. Nothing at this time, I think.

Senator PLUMB. If anything further occurs to you at any time, the committee will be glad to hear it.

STATEMENT OF L. D. BAILEY, OF GARDEN CITY.

Senator PLUMB How long have you lived in Kansas?

Mr. BAILEY. Thirty-three years.

Senator PLUMB. How long have you lived in this part of the country?

Mr. BAILEY. Six years.

Senator PLUMB. You can state to the committee, in your own way, the results of your experience and observation here concerning the great question of what has been done and is doing here in regard to crops and the artificial water supply, present and prospective.

Mr. BAILEY. The subject is a very important one. My experience covers only six years here. The result of it is that with water we can

raise anything. Without water there are some things that we can raise. With water I have never found a more fertile soil. My first experience here showed that we could grow an abundance of sweet potatoes, Irish potatoes, onions, and, in fact, almost everything but corn. That was in the fall of 1883. I have never seen better Irish potatoes than we had here, and there was an abundance of them?

Senator PLUMB. Were they grown without irrigation?

Mr. BAILEY. No; they had to be irrigated. But I have since raised some crops without irrigation; I think sorghum, millet, and cattle corn. I think those are reasonably sure.

Senator PLUMB. How about rye?

Mr. BAILEY. Three years ago I grew a small patch of rye. I believe it can be made a profitable crop here by putting it in thoroughly and early, so as to take the chances of the rains. Still our prospects for farming without other sources of water supply than the clouds are not brilliant. Our prospects are not good unless we can get water from the river or from underneath the river. My well is 65 feet deep and is inexhaustible. It is on the thirty-eighth parallel of latitude. The railroad runs along that parallel for a good many miles, keeping on the north side of the Arkansas rise up to the State line and beyond. The road does not follow it all the way. I have known as many as one hundred teams (two-horse and four horse) to water at my well at a single day and to use a good deal of water, but I never perceived that it made the slightest difference in my well. That, I think, is the general character of all the wells in this neighborhood. When you get down to where the water is there is an abundance of it.

Senator PLUMB. What is the depth of water in the well?

Mr. BAILEY. I do not know.

Senator PLUMB. How deep does it stand below the lowest point of excavation?

Mr. BAILEY. The well was there before I was. It had been abandoned and caved in to some extent. There never was any curbing there, and there never was any wall.

Senator PLUMB. Is there now?

Mr. BAILEY. Not a particle of wall. It shows the peculiar character of the formation. The water never seems to come any higher or to get any lower.

Senator PLUMB. Is there a current there?

Mr. BAILEY. I have not observed it.

Senator PLUMB. Is there sufficient water to be of service for irrigation if it could be lifted to the surface?

Mr. BAILEY. I think enough could be drawn from that well to irrigate perhaps 2 or 3 acres, and I think a good many wells could be got from the same quarter-section.

Senator PLUMB. Are you apparently on the level of the Arkansas?

Mr. BAILEY. I think so. I am on the highest land there is in sight. Mr. Spear's place, about a half mile west, is a few feet lower on the surface, and the well is about that much shallower. I think he went down 55 feet. There is a well a little way east of mine that is about 50 feet in depth, and on lower ground than mine. There is another well half a mile east that is about 53 feet, and on ground just a little lower than mine. A mile and a half farther there is another well that is about 52 or 53 feet in depth.

Senator PLUMB. Then you think that all that section of country is *underlaid* with the same sheet of water that flows on the Arkansas bottom, *and in* the channel of the Arkansas River?

Mr. BAILEY. Yes.

Senator PLUMB. It is fresh water?

Mr. BAILEY. Yes. The formation changes after while; it is sand or gravel after you get to the water, but until you get there it is the kind of earth that you see at Kansas City. It stands without any walling, and is destitute of moisture. Yet in a well half a mile from my place the men who were digging found a root 10 feet deep about as thick as my thumb. I thought that remarkable, and suggested to them to follow it down and see how deep it went. They cut it off at a depth of 48 feet, and it was then about the thickness of a lead pencil. At 53 feet they struck water. That shows the peculiar character of that formation.

Senator PLUMB. Is there anything in your experience that shows where the artificial supply is to come from beyond that suggested by the water on your place?

Mr. BAILEY. The underflow of the water on my place is in my judgment just the overflow of the water from the Arkansas River, but I think there is an inexhaustible supply of water under this whole country. The sand in which water is found in the bottom of the wells about there seems to underlie this whole country; whenever you find water you find it under that sand; how deep that sand formation is I do not know; it is probably hundreds of feet deep, and is probably entirely saturated with water. My idea is that if we could cut down a section of ground here deep enough to strike that water and avail ourselves of the whole of its full volume, and then lead it out, we would find it very useful for irrigation. There is a fall of about 7 feet to the mile from the Rocky Mountains to the Missouri River. If we could avail ourselves of that fall we would have the benefit thereof by digging down to this sheet-water, this inexhaustible supply, at about the State line, and if we struck it at say 50 feet in depth, we would only have to go a few miles to spread it all over the surface. That theory may need demonstration, but I am inclined to take a good deal of stock in it myself. It may be practical to take that underflow and by availing ourselves of this uniform fall of about 7 feet in the surface of the land we could bring that water out and on to the surface to very great advantage.

Senator PLUMB. Is there anything further that occurs to you?

Mr. BAILEY. Nothing just now.

STATEMENT OF J. W. GREGORY OF GARDEN CITY.

Senator PLUMB. You reside in Garden City?

Mr. GREGORY. Yes.

Senator PLUMB. What is your occupation?

Mr. GREGORY. I am publisher and editor of a newspaper.

Senator. PLUMB. You have published some articles on the subject of artificial water supply in this section of the State, have you not?

Mr. GREGORY. Yes.

Senator PLUMB. Can you furnish copies of those to the committee?

Mr. GREGORY. I think I can furnish copies of the most important ones.

Senator PLUMB. You have some statistics on the subject, which you can let us have?

Mr. GREGORY. I have some figures that I can give you.

Senator PLUMB. Of course you understand that in the limited time at our disposal we *can not very* well go into the subject as thoroughly

as you could go into it in writing at your leisure, but I should like you to state now in a general way your ideas in regard to it, and then supplement your statement by furnishing to the committe, in writing or in print, such other matter as you may have bearing on the situation.

Mr. GREGORY. Do you wish me to confine what I have now to say to the idea of obtaining a supply of water?

Senator PLUMB. Yes, generally to that idea, without the elaboration which you have given it heretofore in publication, because we can get it in more compact form by the method I have suggested.

Mr. GREGORY. Of course these are largely matters of opinion, and I would like to preface what I have to say by making one remark with regard to artesian wells and storage reservoirs, as applied to this country.

I believe that an immense amount of water can be obtained from artesian wells, and that a considerable amount can be saved by storage reservoirs, but the evidence that has already been presented before your committee shows that the expense and uncertainty attending the obtaining of water by means of artesians wells would be great compared with the amount of land that could be irrigated. No doubt a great deal of land will be irrigated in the course of time.

As to utilizing the storm-falls, the draws and ravines that are in this country are so few and scattered, and of such a character, and the basins that they would drain are so small, that the amount of water which could be stored and used from them would be very small indeed, and hardly appreciable, in western Kansas. The draws that are large, and drain a considerable area, so far as I know, reach down through this subterranean bed of sand, and it would be very difficult to store water in them. So that if in this southwestern country we could only rely on those two means of obtaining water we might as well, it seems to me, consider it a fact that it would be a great many years, perhaps centuries, before this whole country would be irrigated.

My experience and observation, however, have convinced me that there is an abundant supply of water easily available that will not only irrigate the Arkansas Valley but also the broad plains north and south of us that have been mentioned in your hearing by gentlemen from Scott, Haskell, and other counties. I refer to the supply of water which we know exists in this bed of sand that underlies not only the Arkansas Valley but reaches out to places on either side of it at a considerable distance therefrom. To undertake to utilize that by digging, as was suggested by one gentleman, to a depth of 50 feet, to bring that water to the surface, would cost so much that it would not be practicable; but by opening fountains along the Arkansas River, where the water is only about 3 feet below the surface, and taking advantage of the general fall of 7½ feet to the mile, water can be carried to the highest land in this part of the country, excepting occasioual knolls, and the percentage of that would be very small.

I would like to present a few figures on which I base my estimate of supply. I do that as much for the benefit of the people here as anything else. The opinions expressed in these papers are the opinions that I hold, and which I have satisfied myself are correct. I have in my hand a letter from Mr. R. A. Steen, of La Junta, Colo., superintendent of water service on the western division of the Santa Fé Railroad. In answer to questions which I asked him about the middle of last May, he informs me that from Dodge City to La Junta, inclusive, the Santa Fé Railroad has fifteen supply wells that are an average distance of 15 *miles apart.* They have an average depth of 21 feet, the shallowest

being 17 feet at Lamar, Colo., and the deepest 27 feet at Cimarron, Kans.; the average diameter of the wells is 16 feet; the average depth of water in the wells is 8 feet. There is but one of those that has a pumping capacity that tests the capacity of the well to any considerable extent; that is at La Junta, Colo. That well has a capacity of 255,150 cubic feet per twenty-four hours.

The most abundant supply of water in any of these wells is found at La Junta and Las Animas, Colo. I asked him this question: What is the character of the formation in which the water is obtained? His answer is, "Sand or gravel." Another question I asked him is this: Where water is obtained from strata of sand and gravel what is the total depth of the water-bearing stratum to the best of your information? To that his answer is: "At La Junta, about 10 miles east of here (this was written from another point on the road) we have wells sunk 8 feet in the gravel, but none of the wells reach through this subterranean water-soaked sand." Another question I asked him was this: If any of your wells obtain water from veins instead of sheet, state the circumstances. His answer is: "None; they all obtain it from the subterranean water-bearing sand or gravel; none of them pierce or go through it." I then asked him: If any of your wells obtain a supply from what is popularly named sheet-water, please state what is the lateral extent each way of the sheet water. To that his answer is: "At La Junta the water-bearing strata extend about 2,000 feet south of the river." He did not venture any further opinion. That gives some idea of the extent of this water east and west along the river, and shows that the depth is very considerable.

As to the extent north and south of the river, I addressed some questions to Mr. J. S. Humphrey, formerly water surveyor of our county, now residing at Findlay, Ohio, an educated civil engineer and a very conservative man, and one in whose judgment all people who know him will have great confidence. He says:

I will give you all the facts that I know about the water supply in the Arkansas valley. In sinking the well of the Garden City Water-Works we struck water at 8 feet from the surface, in coarse gravel. This gravel had a depth of about 8 feet, at which point we came into a rather fine sand, which was not so good a water-bearing stratum as the gravel. We tested this to a depth of about 25 or 26 feet and could not detect any change. The construction of our well-wall was range rock-work laid in cement, so as to exclude all water except such as should come from the bottom of the well. The excavation of the well was stopped by direction of the council at 19 feet in depth. The capacity of the pumps is 1,000,000 gallons in twenty-four hours; the capacity of the well somewhat less; I do not now recollect how much less. If the well had a porous wall, say 16 feet deep, the water supply would easily be 2,000,000 gallons in twenty-four hours. I regard the water supply as inexhaustible. I believe that the water underlying Garden City is one sheet, extending from the southern edge of the sand-hills (that would be about 10 miles south) northward to some point between Scott City and the Kansas Pacific Railway.

Scott City is 38 miles north of here. Mr. Humphrey further says:

In the Arkansas River valley is a river of water flowing eastward which can be tapped for irrigation at almost any point and the water supply is limited only by the capital at command. A clear water system of irrigation can be secured independent of the river, and which, once constructed, will not require the cleaning of ditches, and will prevent the spreading of weed-seed all over the land. Freshets in the river will not wash away the dams and sluice-gates. The Arkansas River valley has a great future before it, and those of you who can hold on will be amply repaid for so doing.

There is another thing that indicates the depth of this supply. Experimental boring was made here which extended to a depth of 900 feet. I obtained the facts in regard to it from a gentleman who superintended it for the county at the time and had his figures, but have lost

them. I remember, however, that he found continuous succession of water-bearing strata to a depth of 120 feet under Garden City.

You have already had statements from other gentlemen, including a gentleman who lives several miles north of us, one who lives several miles south of us, and one from Scott City, showing that they had also struck this same subterranean sheet-water. In the river valley this water is only about an average of 3 feet below the surface.

In a letter from Mr. W. E. Trull, of Garden City, who was city engineer for a long time, after giving the depth of the city well, which is 19 feet, he states that its extreme supply for twenty-four hours, as shown by tests when he was superintendent of the water-works, was 800,000 gallons. He was in charge of the works for twenty-two months. That well is located in the second bottom. That surface is on an average 8 feet higher than the surface of this underlying supply of water. In the first bottom it is an average of 3 feet at some places, at others 4, and still others 5. Mr. Trull gives the average depth at which the water stands at this well as 12 feet, out of a total depth of 19. The average depth of wells in Garden City he gives as 18 feet. The average depth of water in the first bottom next the Arkansas River is 3 feet. He gives it as his opinion that the depth of this first stratum of water-bearing sand is 18 to 25 feet and that there is but a thin scale between that and the next.

I am satisfied that the State of Colorado can not deprive us of water by continuing in the dog-in-the-manger policy of preventing the water from crossing the State line. We can obtain a sufficient supply of water from the underground source, which would be out of their reach except by pumping, and if they resorted to pumping, there would be enough for our use and theirs too. Enough could be got by bringing this underground supply to the surface in less than a mile and, by penetrating the sand to a sufficient depth, it seems to me that the capacity of these wells could be much increased. We certainly could secure all the water we could use, the only limit being the amount of land necessary to irrigate and the amount of money necessary to irrigate it.

I am satisfied from the investigations I have made that the water to fill one of our large irrigating ditches can be secured in that way with less expenditure of money than would be necessary to put in dams on the Arkansas River, and also, as Mr. Humphrey suggests, free from the noxious weeds and weed-seeds that come down; and that we would have the water at the time we need it most.

I do not believe that it is practical for us to obtain this system of irrigation within a time that will enable it to benefit the people now here, unless the Government will take hold of the matter and see it done systematically and thoroughly, and also start the work. It ought to be done systematically, because otherwise there will be areas that will be furnished water by two or three ditches, more ditches than they need, while others will be neglected. Besides that, where it depends on private capital the people who own the land will have to pay or give up of their property a great deal more than they ought. You all know how matters of that kind work in reference to railroads, etc.; they often cost more than they are worth. So far as we are concerned here, it is better to lose half our lands than all of it, and have the water. But we can not make this a successful agricultural country without irrigation.

We do not think that in asking the Government to take hold of this matter we are asking it as a matter of charity, at all. Since the Garden City land district was organized in 1883 there have been paid to *the Government* for lands in that district $4,450,943.86. That is not ex-

actly accurate, but it is within a few dollars of the exact amount. This district had paid a good deal of money into the Treasury before it was organized as a separate district. It was formerly a part of the Larned district, so that we will be fully justified in saying that the land in this district has paid into the Treasury of the United States $5,000,000, and if the Government will devote the one-fifth part of that sum to making this land habitable, I think you can safely rest assured that it will return in the way of taxable property alone, not saying anything of its value to the people, one-hundred fold the amount of the investment by the enlistment of private capital in the development of the resources of this country. I think that a very conservative estimate.

Senator PLUMB. Is it your idea that the Government should engage in furnishing the water?

Mr. GREGORY. My idea is that the Government should systematize the matter and start it. Beyond that I do not think the Government would need to go.

Senator PLUMB. How do you mean to "start it?"

Mr. GREGORY. In the first place, the Government should make surveys and establish where the high land lies between the streams, and fix the places where the underflow from the Arkansas valley and from the valley of the Cimarron, the Beaver, and the other streams can be most advantageously tapped and turned in to perhaps a long central canal. This is merely a theory, of course. But if a canal were established on the high land, for instance, near Garden City, and could go up into Colorado, it could be kept constantly filled by pools along the river, and the flow turned in from a main canal as soon as the supply could be raised to that point. South of us the same thing could be done. There is no question but what the water could be taken across the sand hills at several places. I think the Government ought to appropriate money sufficient to make the start and see that it is systematically done, and should also regulate it after it is done.

Senator PLUMB. You mean that it should make the survey?

Mr. GREGORY. That it should make the survey, and also establish as many fountains or supply sources as are necessary to make a thorough demonstration of the practicability of the plan. We have these wells. We have within the present limits of Garden City a lake, the bottom of which is below the level of the river, from which water runs the whole year round. That is a practical exemplification of this system, showing that it can not help but be a success.

Senator PLUMB. Then in what way would that which the Government could do add to the certainty of the situation?

Mr. GREGORY. It would not add to the certainty, but you have already heard the condition of our people. If we must wait for the uncertainty of private capital, we must wait from five to fifteen or perhaps thirty years before we can make it a success.

Senator PLUMB. Do you think that private capital would go into competition with the Government?

Mr. GREGORY. No; but I think it would act in accord with the Government.

Senator PLUMB. What is the scope of your idea?

Mr. GREGORY. I can not say that I have developed it.

Senator PLUMB. You say that the Government ought to make surveys, and then that it ought to make these pools for the purposes of demonstration, but, according to your statement, it is demonstrable now.

Mr. GREGORY. It is.

Senator PLUMB. Demonstrable from what can be seen as the result of the investigation of private parties?

Mr. GREGORY. It is not a question of demonstrating it to us, but of demonstrating it to those who have money.

Senator PLUMB. To what extent would the Government need to carry on the work in order to make that demonstration?

Mr. GREGORY. It is impossible for me to say that; but I think the fact that the Government had taken hold of it would give it publicity and bring it to the attention of people who have capital--an attention that can not be brought about in any other way.

Senator PLUMB. Do you think that if the Government were going to dig ditches, fountains, and so on, private capital would also go into it?

Mr. GREGORY. I do.

Senator PLUMB. In competition with the Government?

Mr. GREGORY. No.

Senator PLUMB. If the Government should have a fountain and a ditch and got its money by taxation from the people, of course it would not need any stockholders and would not pay dividends. It would either have to sell the water to the people, keeping up a corps of assistants here, or else it would have to give it to them, and if it gave it to them, of course no private capital could engage in it, because private capital could not afford to sell water in competition with those who gave it away. If the Government were selling the water, there would always be a pressure upon those of us who represent these people, as well as upon others, to constantly abate the charges, forgive the debt, etc.; so that no man would feel safe to invest money in that sort of competition. As you have given a great deal of attention to the subject, I would like you to address yourself to that point. I would like to see what your idea is as to just how and to what extent the Government ought, as you think, and could, with propriety, according to your notion, engage in it.

Mr. GREGORY. I do not believe that the Government of the United States should go into the irrigation business at all as a matter of profit.

Senator PLUMB. Nor as a matter of loss.

Mr. GREGORY. No, nor as a matter of loss, but as a matter of right.

Senator PLUMB. And to what extent?

Mr. GREGORY. We consider that this land has cost us enough, and that the conditions have turned out so adversely and so differently from what was anticipated, that we are entitled to such consideration from the Government as that it shall put money enough into this matter to make a good agricultural country here.

Senator PLUMB. What I want to know is how the Government should do that.

Mr. GREGORY. The extent to which the Government should go would be, as I have stated, to the extent of demonstrating what should be done, and whatever works may be constructed by the Government need not be lost by any means, either to the Government or to the people.

As I understand it, this Government is of the people and for the people. We are a part of the Government, and expect consideration from it. Such irrigation works as I have mentioned might ultimately be turned over to the States or counties and communities, or to private corporations, but under such restrictions as that the price of water might be lowered.

Senator PLUMB. Would that be any inducement to private capital?

Mr. GREGORY. If the Government would invest $1,000,000 and allow *private capital* to take hold where the Government left off, in such a

ay as that they would make money out of it and let the people have ie water, I do not see where the injustice would be.

Senator PLUMB. Somebody has to do something about this matter, nd we are here to get the opinions of the people. We want to know 'hat they expect.

Mr. GREGORY. If we had the assurance that there would be anything one at any early period, I am satisfied that the person to produce the lan would be on hand.

Sena'or PLUMB. If we are to consider this question with the view of etermining what we ourselves would recommend, we ought to know he desires of the people here on that subject.

Mr. GREGORY. Just how the connection should be made, as to what ould be expended by the Government——

Senator PLUMB. But you have not yet answered my question. Do ou think the Government should put in a ditch to supply water to the ersons wanting it?

Mr. GREGORY. Yes.

Senator PLUMB. I did not know whether you wanted to do that, or o stop with the survey.

Mr. GREGORY. I would not have it stop there by any means.

Senator PLUMB. The Government, you think, should go to the extent f building a single ditch at least, to supply water to persons along the ine of that ditch?

Mr. GREGORY. I would not confine it by any means to a single ditch. would not confine it to less than enough for these plains.

Senator PLUMB. Then you think the Government ought to put in all he ditches necessary?

Mr. GREGORY. I think it ought to begin the work and carry it on to point where private capital would be ready to carry it on. I am atisfied that that will be a very early period. Any one who will come ere and see the results of irrigation can not but be satisfied that here is an immense development in store for the country if we had the se of water.

Senator PLUMB. That is common to the observation of all persons ho have visited the country. Everywhere it is manifest that wher-ver water is applied by means of irrigation great and certain crops re-ult. Of course, the people everywhere would be very glad to have the overnment supply them with water. That brings up, however, the roblem with reference not only to this immediate locality but as to ll parts of the United States. If the argument is based on the idea hat the people here have paid certain moneys for their land and that hat is to be returned to them, of course, that argument is suscepti-le of pretty wide application.

Mr. GREGORY. I would call attention, Senator, to one thing: We ave no rivers to improve and no harbors to clean out. We have ot asked for Government buildings, but we do ask for a chance to ive.

Senator PLUMB. The people of the East have also paid money to he Government, and the people in the eastern part of this State have aid money to the Government, and want to live. It seems to me that our argument should not be based on the idea that the people have ought a quantity of land for which they have paid.

Mr. GREGORY. We will not, for a long time, ask for any Government uilding or river and harbor appropriations, which all the States to east f us have had in great plenty, but we will ask you to devote to our part of the country our share of the money to develop water supply.

Senator PLUMB. That is your share of the money raised by taxation?

Mr. GREGORY. Yes.

Senator PLUMB. That will result in a mathematical calculation as to how much that money was.

Mr. GREGORY. We want our share of it simply.

Senator PLUMB. You want a fair computation on that subject?

Mr. GREGORY. Yes.

Senator PLUMB. Speaking of public buildings, I have no doubt that when the Government wants a Government building in Garden City it will build it, not because the people want it, but because the Government has need of it.

Mr. GREGORY.. Yes; I wish to say that the suggestions I make about the water supply are not to be considered as applying solely to this country, but are to be considered as applying also to the valley of the Platte. I think Major Powell shows that 25 per cent. of the arid and semi-arid lands of United States can be made fertile by the use of a small share of the water of the mountains. If we can use a part of the water that has gone down into the subterranean strata it will be an immense gain to the United States.

Senator PLUMB. I understand that your theory of the duty of the Government is not limited to this locality at all. I understand your idea is that wherever the circumstances require it the Government should do the work.

Mr. GREGORY. The Government should begin it.

Senator PLUMB. That opens up a great question, because this condition of things exists over one-third of the area of the United States.

Mr. GREGORY. Well, none of us know the cost of the work. A gentleman in Garden City, Mr. Moon, has excavated a reservoir for the purpose of manufacturing ice. That reservoir, I understand, cost something less than $1,000. It is of such depth that it reaches about to the surface of this underground water supply. It is nearly in circular shape. If that were extended and made, say, 25 feet or 40 feet across, and made much longer, the same amount of money would provide a great deal more of a reservoir than when the dirt has to be moved so far as in the case of a circular pool.

Senator PLUMB. Would it be practicable to use that for the purpose of experimenting to demonstrate the general result?

Mr. GREGORY. It would be available as demonstrating a result of a reservoir in connection with it. The quickest and cheapest thing I know of would be to clear out and do a little work in this lake I spoke of in this town. It would not take much money to see in a small way what could be done. I do not believe that if we wait for results to come from small showings we will ever have the general result that ought to come to the people as a whole. While we might here at Garden City obtain results to answer our purpose very soon, we do not feel satisfied with having the matter stop there. We want to see our neighbors east, west, south, and north of us have as much benefit as they can.

Senator PLUMB. You do not think that on a demonstration of this kind private capital would be induced to make investment?

Mr. GREGORY. I think that it may be, but it would be so slow that by the time it would be done the capitalists and monied men would have the land and would have the profit that the poor people ought to have.

Senator PLUMB. You mean that it would not be done quickly enough?

Mr. GREGORY Yes.

Senator PLUMB. Is there anything further you wish to state?

Mr. GREGORY. Nothing further than to impress upon you as far as possible the very great importance of their being something done; also the fact that if we depend upon private capital we depend on it to make development for somebody else and not for ourselves.

Senator PLUMB. You may, of course, supplement what you have said by submitting in writing any data that you think will throw light on the subject.

The CHAIRMAN. What amount of land do the people here generally have—how large are the farms?

Mr. GREGORY. There is hardly any one here who has less than 160 acres. As to the farmers I think it will be fair to say that among those who came early each man would have about 320 acres of land, because almost all of them took a homestead and pre-emption claim and also a timber claim. But perhaps at the present time that would not be the case. Perhaps 160 acres would be the quantity.

The CHAIRMAN. Are you aware that a person does not need as much irrigated land as other land?

Mr. GREGORY. We are aware that a person can make a good living on 10 acres of this land.

The CHAIRMAN. If the Government did not do this, would it not be practicable for the people to join together and contribute some of their land toward the building of a ditch?

Mr. GREGORY. If we could get the men to supply the money and the water I do not think there is a man in this country that would not give 80 acres out of his 160 to get water. If he had to go as far even as 120 he might do that; but we do not think it is just to the people to require that of them.

The CHAIRMAN. I did not allude to that, but whether there was any way out of the difficulty except the Government way.

Mr. GREGORY. There is that way that I have just spoken of, but it is a very hard way.

STATEMENT OF A. T. MOON, OF GARDEN CITY.

Senator PLUMB. Where do you reside?

Mr. MOON. In Garden City, Kans.

Senator PLUMB. How long have you resided here?

Mr. MOON. Since the spring of 1885.

Senator PLUMB. What is your business?

Mr. MOON. I am engaged in the ice business.

Senator PLUMB. Have you given some attention to the question of the artificial water supply in this section of the country?

Mr. MOON. I have had no great experience in irrigation, but as to this question of obtaining water from the subterranean supply I have made some little experiments in the way of excavating an ice pond and got information in that way.

Senator PLUMB. State what your information is.

Mr. MOON. In the winter of 1886 I excavated a pond on what is known as the first bottom. The pond contains about 2½ acres, and the excavation is an average depth of about 3 feet. We took off all the surplus down to the sand. It was perfectly dry and easily worked until we came to the sand. When we came to that the water rose and made it very muddy and hard to work. We did not get it so deep as we intended to get it.

That pond is supplied from a natural lake about a half mile above. The bottom of the natural lake is probably a foot below the sand in the

river. There is a continual stream flowing all the year round. The volume of the stream varies a little every season. It is about the lowest now that we have ever seen it. In the dry season it does not flow as much as in the spring or in the wet season, but it has never been known to go dry. I filled this ice pond from the branch which flows down from the natural pond above. The fall is sufficient.

Senator PLUMB. Would there be any difficulty in digging it out to the depth of 10 or 15 feet, and getting out the sand?

Mr. MOON. Yes; I think there would be some difficulty in doing that.

Senator PLUMB. Does the sand flow with the water?

Mr. MOON. It does to some extent, but not very much.

Senator PLUMB. It is not a quicksand, then?

Mr. MOON. No; I would not call it that.

Senator PLUMB. Is there gravel in it?

Mr. MOON. There is some gravel, but we drove through it with teams. Further excavation may be possible there, but we did not make it.

Senator PLUMB. You think the water in this lake or pond is got by flowage from the lake above?

Mr. MOON. There are some who think the lake above is supplied by a spring, but I do not see why we should have a spring in the middle of a lake-bed. It looks to me as if it came from the level of the river.

Senator PLUMB. Does that water from the lake above flow in a channel, or is it a general sheet of water following the trend of the river?

Mr. MOON. The channel follows the trend of the river. This natural channel looks as if it had been cut out some time by the river. It was probably an arm of the river. I have dug down on the east side of the lake, and I find this same sheet of sand on each side, which, it seems to me, did away with the theory that there was a spring in the lake.

Senator PLUMB. You regard it as settled that in a large portion of this bottom here the water is found on the same general level as the bed of the river?

Mr. MOON. Yes; I think it is also true that in an excavated pond the water will rise higher than it is found to be in the river.

Senator PLUMB. You think it will rise above the level of the water in the river?

Mr. MOON. Yes; probably by capillary attraction. The water is higher in our pond than in the river, which is only about 2 rods distant.

Senator PLUMB. How much higher?

Mr. MOON. I do not know exactly how much, but I know it rises higher. Of course other sources contribute to it, and the water coming from above has something to do with it.

Senator JONES. How much higher than your pond is the natural lake to which you have referred?

Mr. MOON. About 5 or 5½ feet. The upper end of it is from a mile to a mile and a half farther up the river, and the natural fall is toward the artificial pond.

The committee here took a recess of an hour, after which the session was resumed, the same members being in attendance.

STATEMENT OF WILLIS BRYANT, OF SCOTT COUNTY.

Senator PLUMB. Where do you reside?
Mr. BRYANT. In Scott County; about the center of it.
Senator PLUMB. How long have you resided there?
Mr. BRYANT. Three years and a half.
Senator PLUMB. Where are you from?
Mr. BRYANT. Montgomery County, in eastern Kansas.
Senator PLUMB. Please state to the committee the result of your observation in regard, first, to the necessity for an artificial supply of water in this section of the country, and secondly, as to the method by which it can be obtained.
Mr. BRYANT. There is no doubt but that they need a little more water here; yet they have raised quite a considerable crop there this year; good wheat, very good oats and rye, and some very good corn. With a little assistance in the way of artificial water they would have a very good crop there this year.
Senator PLUMB. What is the annual average precipitation in your part of the county?
Mr. BRYANT. About 14 inches, I think, on an average.
Senator PLUMB. Not more than that?
Mr. BRYANT. No; it runs a little higher some years—as high as 18 or 20 inches.
Senator PLUMB. About how high has it been this year?
Mr. BRYANT. It is 13 inches, about.
Senator PLUMB. Is it distributed pretty evenly?
Mr. BRYANT. No; the rain is local rather than general.
Senator PLUMB. Is there any particular part of the county that from year to year has more than any other part? Is there more precipitation along the streams?
Mr. BRYANT. There is probably a little more. Last season a better crop was raised in the north part of the county. This season it has been pretty generally distributed all over.
Senator PLUMB. What do your people chiefly raise?
Mr. BRYANT. This year our people are commencing on wheat.
Senator PLUMB. Is it a fair crop, and is the wheat full?
Mr. BRYANT. It is a very good crop, and of full wheat.
Senator PLUMB. Have they tried spring wheat?
Mr. BRYANT. No. In addition to the wheat, they have rye and corn, and cattle-corn. They have also some alfalfa, though not very much. Early potatoes did very well this year.
Senator PLUMB. Please state the result of your observation in regard to the chance for an artificial water supply?
Mr. BRYANT. About the only hope that our people look for is the storage of the rain-fall and the assistance of the Amazon ditch now being constructed, which will irrigate about one-third of the county.
Senator PLUMB. That is supplied from the Arkansas River?
Mr. BRYANT. Yes.
Senator PLUMB. If you get all the water you can irrigate the area you have named?
Mr. BRYANT. Yes; engineers are now surveying with the view of making storage reservoirs to take care of the water that comes down in the fall and winter. Some have an idea that they might get relief from artesian wells. Nothing of that kind has been tried there.
Senator PLUMB. At what depth have they found water?

Mr. BRYANT. At 50 feet depth in the towns. It is pretty much the same all the way round. It seems to be sheet water.

Senator PLUMB. That is found all around the valley of the Arkansas River?

Mr. BRYANT. Yes.

Senator PLUMB. You are on the water-shed of the Smoky Hill?

Mr. BRYANT. Yes.

Senator PLUMB. From what direction must the artificial water supply come?

Mr. BRYANT. From the Arkansas River.

STATEMENT OF J. A. WILSON, OF KEARNEY COUNTY.

Senator PLUMB. Where do you reside?

Mr. WILSON. In Kearney County, Kans.

Senator PLUMB. That is the county adjoining this?

Mr. WILSON. Yes; on the west.

Senator PLUMB. How long have you resided there?

Mr. WILSON. Two years.

Senator PLUMB. Please state to the committee the result of your observation in regard to the necessity for an artificial supply and the source from which it might be obtained, as well as the method of obtaining it.

Mr. WILSON. I have seen the irrigation from the ditches within reach of the Arkansas valley proper, and have also noticed the natural fall of water. My idea is that the best agricultural country could be reached by storing the waste water that passes through the draws.

Senator PLUMB. You mean what falls on the hills, on the surface of the earth?

Mr. WILSON. Yes.

Senator PLUMB. Is the topography of the country such that storage could be carried on on a large scale?

Mr. WILSON. It seems to me that it is. There are large "draws," some of which are a mile wide, and the water could be stored there so as to give a surface reservoir of 50 to 100 acres perhaps.

Senator PLUMB. What you speak of as a "draw" is what we know generally as a ravine, is it?

Mr. WILSON. Yes.

Senator PLUMB. You mean that by closing the mouths of those ravines or draws, and getting the water naturally belonging to them, you would get enough water to aid materially in irrigation?

Mr. WILSON. I think so.

Senator PLUMB. At what time is this water to be had?

Mr. WILSON. It falls in the early spring, except during the last season. I notice that it has fallen in August and September and in the winter time. More falls in the spring and fall than at other times. There has been waste water that has washed out the embankments and ditches several times this last season.

Senator PLUMB. Have you had any experience with artesian water in your county?

Mr. WILSON. No.

Senator PLUMB. Are there any artesian wells in your county?

Mr. WILSON. No.

Senator PLUMB. Have any efforts been made to obtain them?

Mr. WILSON. No.

Senator PLUMB. What reliance can be placed upon the water in the Arkansas River?

Mr. WILSON. From what I have heard others say, they have now a greater slope of country subject to irrigation than the surface supply of water will warrant.

Senator PLUMB. That is, the present ditches can not supply the lands that lie under them?

Mr. WILSON. No.

Senator PLUMB. Is that because of the short supply of water in the rivers this year compared with former years?

Mr. WILSON. The two seasons that I have been here they have had failures of crops for want of water.

Senator PLUMB. What, in your opinion, is the occasion of there not being sufficient water?

Mr. WILSON. There not being sufficient rain-fall, or there having been a limited snow-fall in the mountains.

Senator PLUMB. Is there any other suggestion you wish to make on this subject?

Mr. WILSON. I will only state that I am enthusiastic on this theory of the reservoir system. We have great natural advantages by reason of the natural fall of slope of the land, and the ravines or draws. I believe the water could be very easily stored in sufficient quantities to irrigate the land.

Senator PLUMB. What proportion of the land do you think would be irrigated by storing the water which is the result of storms at seasons of the year other than the growing season; that is, what proportion of the water that descends goes to waste in the season of the year when it is not needed for irrigating the crops?

Mr. WILSON. I think there is sufficient to irrigate all the land.

Senator PLUMB. You think the annual precipitation is sufficient if it could only be used at the proper season of the year?

Mr. WILSON. I think so.

Mr. CLARK. I should like to have the privilege of asking a question. I wish to ask Mr. Wilson by what means he would lift the water out of a low draw to irrigate the table-lands above?

Mr. WILSON. I would not undertake to irrigate the lands above. I would irrigate the lands below. I suppose that that water to be carried out and utilized to the best advantage should be carried out in hard tiles. The soil is all sandy around here and absorbs water very rapidly. To conduct it out overland through ditches would waste a considerable portion of it. I think the water should always be taken out from the bottom, so that you could utilize all the water in the mountain lakes or reservoirs, and that it should be taken out by means of hard tiling, with proper machinery for shutting it off at the proper times.

Mr. CLARK. Then you do not expect to irrigate the small valley below the draw?

Mr. WILSON. We have a natural fall in this country of 8 or 9 feet to the mile.

Mr. CLARK. Is it a fact that if you took it along the river or stream in this country where the draws come in, and were to carry it by a flume, each half mile you would come to another draw—if so, how would you pass over that draw?

Mr. WILSON. A system of reservoirs would, I suppose, have to be arrangedfor, to accommodate the country, and if they struck another draw they would have to arrange to get a fall of 2 or 3 feet for the water.

Senator JONES. There is no practical difficulty in that. Everywhere water is carried in flumes above water-courses.

Mr. WILSON. If water is carried by proper machinery so that it will not be wasted by absorption and evaporation it can be carried to the proper place.

STATEMENT OF W. E. HUTCHINSON, OF ULYSSES, GRANT COUNTY.

Senator PLUMB. Where do you reside?

Mr. HUTCHISON. In Grant County.

Senator PLUMB. In what part?

Mr. HUTCHISON. At Ulysses.

Senator PLUMB. How near are you to the Arkansas River?

Mr. HUTCHISON. The northern part of our county is 12 miles from the Arkansas.

Senator PLUMB. Please state to the committee the result of your observation; first, as to the necessity for an artificial supply of water in your county, and, secondly, your view as to the source from which that supply must come if it is to be obtained.

Mr. HUTCHISON. I have been in Grant County two years, and I see the need of having something to help out the crops. We have an early spring. A superabundance of water comes along then; in July and August we have little or no water. There is great need of an artificial supply. My idea is that we will have to get that from the Arkansas. It is very shallow to water in our county, and probably an artesian system would have to go deeper than in other places.

Senator PLUMB. How deep do you have to go for water?

Mr. HUTCHISON. On the west half of the county about 40 feet, and on the east half about 100.

Senator PLUMB. Is there an ample supply then?

Mr. HUTCHISON. Yes. Some people say that in digging wells the augur would drop 1½ feet, and sometimes as much as 6 feet.

Senator PLUMB. Does the water rise pretty well up in the well?

Mr. HUTCHISON. Quite a distance.

Senator PLUMB. There have been no artesian wells dug in your county?

Mr. HUTCHISON. No. The sand hills lie between us and the Arkansas and there might be difficulty in getting the water across, though not a great deal, I think.

Senator PLUMB. What success have your people had with their crops?

Mr. HUTCHISON. The crops are only a partial success. This year we have not had half a crop.

Senator PLUMB. What is your principal crop?

Mr. HUTCHISON. Corn. We raise oats sometimes. Alfalfa does well in the wet part of the season, but it is no good after the dry season commences.

Senator PLUMB. Have you tried sorghum, cattle-corn, or other fodder crops?

Mr. HUTCHISON. Yes.

Senator PLUMB. So far as any known fact is concerned, your reliance is on the Arkansas River?

Mr. HUTCHISON. Principally. We have two streams, the Cimarron *and* Bear Creek, from which water is easily obtained and we have often *thought of making* reservoirs and retaining the water when there was

an excess of it. Bear Creek could probably supply all our county. It would be down grade.

Senator PLUMB. Is there anything further you wish to say?

Mr. HUTCHISON. I do not think there is.

STATEMENT OF J. C. GUY, OF HAMILTON COUNTY.

Senator PLUMB. You reside in Hamilton County, I believe?

Mr. GUY. Yes.

Senator PLUMB. How long have you resided there?

Mr. GUY. Between one and two years.

Senator PLUMB. Where were you from, originally?

Mr. GUY. From Missouri.

Senator PLUMB. In what part of the county do you live?

Mr. GUY. At Syracuse, in the center of the county.

Senator PLUMB. Please state the result of your observation as to the necessity for an artificial water supply in that county, and the result of your observation as to the best method of getting it.

Mr. GUY. My view of the necessity of getting a water supply is very decided. We have a little over half a million acres of arable land in that county that is susceptible of irrigation, with water; and without water it is almost worthless. We have about 70,000 acres running through the center of the county that could not be irrigated. In the western part of the county we have good artesian wells to the depth of 300 feet, but I do not think they would be sufficient to irrigate any considerable amount of land for agricultural purposes.

Senator PLUMB. How many wells have been sunk there?

Mr. GUY. I think two or three.

Senator PLUMB. What is the flow from those?

Mr. GUY. I do not know. They are in the western part of the county, in the town of Coolidge.

Senator PLUMB. What, in your judgment, is to be the source of supply for artificial water?

Mr. GUY. Our opinion there generally is that the only really practicable plan would be that of storage reservoirs.

Senator PLUMB. Taking the water out at the time that there was an abundance of it, and storing it?

Mr. GUY. Yes; principally.

Senator PLUMB. And also storing that which fell during the season of the year when there was no need of the water?

Mr. GUY. Yes. There are times in the year when a great deal of water runs down the Arkansas River, and during that time we might store it in the reservoirs. In that county there is a sheet of water that underlies all the bottom land. You can obtain it by boring, digging, or driving, at from 12 to 15 feet from the bottom. That supply is supposed to be inexhaustible, though we have no information on the subject.

Senator PLUMB. Those two sources, then—the water that flows under the surface along the Arkansas bottom, and that which is a result of precipitation and flows down the Arkansas River during the season—would be the two sources of supply?

Mr. GUY. Yes.

Senator PLUMB. Does the topography of the country afford places for storage to irrigate the county?

Mr. GUY. Yes. *Along the* course of the river there are various long

ravines that might be filled from the river. About 3 miles from the river you come across a nice level plateau—a beautiful country with an excellent quality of soil. I believe that is a better quality of soil than the soil on the bottoms.

Senator PLUMB. Are there natural depressions on the elevated table-lands?

Mr. GUY. Yes; although these storage places would have to be made some distance above and the water conducted down.

Senator PLUMB. Is the land in your county chiefly entered?

Mr. GUY. No; I do not think there is one-half of the county that has been entered and proved up.

Senator PLUMB. I do not mean the final proof, but the quantity of land on which filings have been made. You know that when a man gets a piece of land and files his claim for homestead entry, that is called an "entry." Most of those lands have been filed on, I suppose?

Mr. GUY. Yes.

Senator PLUMB. Have the parties left there?

Mr. GUY. Yes. A few years ago we had four or five thousand; to-day we have not two thousand.

Senator PLUMB. Do you think the people have finally abandoned the land?

Mr. GUY. They have gone away to seek employment—to get a livelihood. They could not raise a sufficient amount of crops to sustain them. They took the land in good faith, and have tried very hard to remain there.

Senator PLUMB. You think, then, that those people mean to come back?

Mr. GUY. They mean to come back if provision could be made by which they could make a living. I have never seen a man go because he wanted to go, but because he was compelled to go; he had to make a living.

Senator PLUMB. There is no doubt about the country being good if you had the water.

Mr. GUY. We have a good country, and only lack water.

Senator PLUMB. Have you any further suggestions to make to the committee on this subject?

Mr. GUY. I have no suggestions further than this, that the project is too great for private enterprise, and if the Government will appropropriate as much money toward bringing those lands into cultivation as they have appropriated for reclaiming the swamp lands along the various rivers of the country, I think we can have in southwestern Kansas one of the best countries in the world.

STATEMENT OF H. K. LESTER, OF SYRACUSE.

Senator PLUMB. Where do you reside?

Mr. LESTER. At Syracuse, Hamilton County, Kans.

Senator PLUMB. When did you go there?

Mr. LESTER. In June, 1873.

Senator PLUMB. You are one of the original Syracuse colonists?

Mr. LESTER. Yes.

Senator PLUMB. How many are left of the original colony?

Mr. LESTER. Three families.

Senator PLUMB. Out of how many?

Mr. LESTER. There were originally twenty-five families.

Senator PLUMB. When did they commence leaving?

Mr. LESTER. It must have been in the fall of 1875 that they began to go.

Senator PLUMB. You have had the benefit of sixteen years' residence in that country. What do you say as to the necessity of an artificial supply of water in order to make agriculture possible?

Mr. LESTER. I am satisfied that eventually the country will be all right without irrigation, but that there is a necessity for it now.

Senator PLUMB. What, according to your observation, will be the most natural or the main source of supply for that irrigation?

Mr. LESTER. If it were in accordance with the existing laws of Colorado, I should say that one great source of supply would be the Arkansas River and the establishment of a system of reservoirs. During the sixteen years that I have been there I have not seen the river so low as at present, unless it was in 1883, and last year. In other years it has seemed to me there was an abundance of water in the river for all practical purposes. In regard to the formation of those reservoirs, I have on several occasions seen the river at Syracuse when over 160 acres of land would be overflowed with water to an average depth of 2 feet, from the rains that came down the creek at Syracuse. It seems to me possible that such water might be used. There might be a system of storage to hold that water. Not at that place alone; but creeks abound there; and at Highland, about 16 miles northeast of Syracuse, Mr. Hadley told me that he saw from 300 to 400 acres of water in the depression, and it looked like a lake. All the water holes are probably filled now.

Senator PLUMB. Has there been any modification of climate since you have been in that country?

Mr. LESTER. The most that I have remarked is the growth of vegetation over the sand hills. Those were entirely bare, or the major portion of them were, when I went there. They are now covered with vegetation. The rain-fall, I think, is also better distributed. One farmer I know raised 30 bushels of wheat to the acre a little north of Syracuse.

Senator PLUMB. You think, then, that in the average of the years since you first went to this county there has been a better distribution of rain-fall than when you first went there?

Mr. LESTER. I think so, and that is the trouble with rain-fall; it is not that the quantity is too great so much as that the distribution is defective.

Senator PLUMB. Do you know what the average rain-fall is in that county?

Mr. LESTER. I do not remember. The first ten years after I went there we never had a rain in January or February, to my knowledge, but of late years we have begun to have rains then.

STATEMENT OF E. L. HALL, OF FINNEY COUNTY.

Senator PLUMB. Where do you reside?

Mr. HALL. In Finney County, about a mile and a half from here.

Senator PLUMB. Where did you come from?

Mr. HALL. From Ohio and Indiana.

Senator PLUMB. You have been engaged in farming since you have been here?

Mr. HALL. Yes.

Senator PLUMB. Are you under ditch?

Mr. HALL. Yes.

Senator PLUMB. Please state to the committee as briefly as you reasonably can the necessity for irrigation and your judgment as to the means of getting it.

Mr. HALL. In the fall of 1885 I came to this county to look up a new location. I took in several of the Western States in my examination. I entered some land in Scott County, about 35 or 40 miles north of here. It was good valley land and I thought I could make a good farm of it. I intended putting about 40 acres of it into orchards. I commenced digging a well and got moisture 3 or 4 feet down, but from that down it was as dry as dust. I made up my mind that I had made a failure. The older a tree gets the more water it requires. I abandoned that thing at once and came here on the ditch. On a ditch I can raise any kind of vegetables or grain or anything else, while away from a ditch nothing of any account can be raised. A man might possibly keep stock by the stuff he raises there, but that is all.

Senator PLUMB. Does the moisture from the irrigation penetrate deeper than it did originally?

Mr. HALL. If you irrigate a piece of land one year it does not need so much moisture the next year.

Senator PLUMB. You do not know whether the water penetrates the subsoil?

Mr. HALL. It will go down to the sand below.

Senator PLUMB. How about the upland?

Mr. HALL. I do not think it will affect the upland.

Senator PLUMB. Your observation is, then, that irrigation is needed here?

Mr. HALL. Yes.

Senator PLUMB. What do you say as to the means of providing it?

Mr. HALL. It appears to me that there might be some arrangement made with the State of Colorado by the United States to store that water if the United States Government were to control it. Plenty of water comes down this Arkansas River to irrigate this whole country, and yet it goes to waste now.

Senator PLUMB. Do you think enough went down this season?

Mr. HALL. This season the river has been up four or five different times, full, nearly to the bank. The ditch I have been on will irrigate perhaps 3,000 or 4,000 acres of land, and enough water goes down that river in one day to fill this ditch for a whole year, I think.

Senator PLUMB. That is your judgment as to the source of supply of water for irrigation?

Mr. HALL. Yes; I think there is plenty of water that can be stored in one place or another to answer every purpose here, and make this a great country.

Senator PLUMB. Is there anything further you wish to say on the subject?

Mr. HALL. I believe not.

STATEMENT OF T. J. JONES, OF GARDEN CITY.

Senator PLUMB. Where do you reside?

Mr. JONES. At Garden City, Kans.

Senator PLUMB. How long have you resided here?

Mr. JONES. Eleven years.

Senator PLUMB. How long have you lived in Kansas?

Mr. JONES. Twenty-three years. I first came to this valley as mail-agent on the road, sixteen years ago last spring.

Senator PLUMB. You have lived in this country nearly ever since it was settled, I suppose?

Mr. JONES. Yes; I was one of the first four or five persons that came here.

Senator PLUMB. Please state to the committee, in your own way, the necessity of irrigation, and your view as to the method by which that object can be obtained?

Mr. JONES. I soon found out that we could not raise crops here successfully and rely upon having them every year, without some artificial supply of water. Some years we could get good crops of one kind by planting early. We might get early corn, for instance, by planting early, but we could not depend on it. I made up my mind that we could save some of the water. I have built over 500 miles of ditches in this and adjacent counties already. That is, I projected them and helped to build them. We have not water enough now to warrant our building any more or even keeping up the repairs on those we have.

Senator PLUMB. The Arkansas River is the source of supply?

Mr. JONES. Yes; when it does supply.

Senator PLUMB. What is the occasion of the lack of supply from the Arkansas this year?

Mr. JONES. The defective supply of snow on the mountains and very light rains. When we have a big rain above it comes down in immense quantities and passes away. If it came steadily we have an abundance of water to irrigate the whole country here.

Senator PLUMB. If the waste water were saved would it supply the ditches?

Mr. JONES. I believe it would supply all the ditches and all the land adjacent for 100 miles each side of the one-hundredth meridian. Then I think that much of it goes to waste by seepage through the country. it is about fifty miles wide, probably.

Senator PLUMB. Is that the uniform width?

Mr. JONES. No; but an average width. It runs from 70 to 30 miles, as nearly as we can tell.

Senator PLUMB. That would require, of course, many more ditches than there now are?

Mr. JONES. Yes.

Senator PLUMB. What amount of land could be irrigated by the existing ditches if the water were abundant?

Mr. JONES. I can not say as to the number of acres, but I should think about twenty or twenty-four townships could be watered by extending the laterals from the present ditches.

Senator PLUMB. By the present water supply?

Mr. JONES. By the present water capacity of the ditches—not by the supply.

Senator PLUMB. Do you mean Government townships, or municipal townships?

Mr. JONES. Government townships.

Senator PLUMB. What proportion of a county?

Mr. JONES. One-half of a good-sized county?

Senator PLUMB. Are any of the ditches now in existence giving a full supply of water?

Mr. JONES. None; not all the season. If we had some way to bring water across the line from Colorado—if our Colorado neighbors would divide with us—I think we could have a good deal more. Somebody has said that it was unlawful, according to the law of Colorado, to bring water across the *line*. *I do not think* that is so. If the Colorado ditches

had given us a prior right we would have had abundance. The Colorado ditches that have been lately built have been taking the supply of water. I have been up and down a good deal, and have been making close observation of that fact.

Senator PLUMB. Then your suggestion of the plan to meet this difficulty is the storing of the water at the time that it flows down, unused?

Mr. JONES. Yes.

Senator PLUMB. State how you would get reservoirs.

Mr. JONES. There are several ways of getting water: one by taking it from beneath the surface, another by rain-fall as it reaches the ground, and the other by getting it from the river. As to taking out the water from the river, I believe that can be done, but many people do not understand how much water is needed to irrigate land. The land here is sandy, and it would take a good deal of water to supply it. Another great objection to building a canal, or something to get the water out with, is that the quicksand makes it very difficult to keep it. It would have to be walled with a still wall.

Senator PLUMB. That only relates to the expense and time of getting it.

Mr. JONES. Yes. That is hardly the proper way to get the water, I think. The other way I mentioned is by building dams across the ravines, etc. The first year or two the seepage is very great, but after a few years of holding the water the evaporation will soon become slight. I think the farmers would in that way save themselves a great deal of hardship.

Senator PLUMB. Is the configuration of the country such as that on the upper level there would be facilities for natural storage?

Mr. JONES. Yes; the table land comes up to a point. The highest point in it is a backbone that averages from 1 mile to 5 miles wide. If water could be stored or gathered from there in these little ravines that come down, a great deal of irrigation could be had from below. You would get sufficient water for the pipe, but not sufficient to water the country.

Senator PLUMB. Many incidental advantages would grow out of that; for example, the facility it would offer for the planting and growth of trees.

Mr. JONES. Yes; and the precipitation would be so great that we would have more rains.

Senator PLUMB. What do you think of having reservoirs to catch the surplus waters of the Arkansas River?

Mr. JONES. Every man in this country will acknowledge that the rains do not penetrate down to this sheet-water. It only wets down from 3 to 6 feet. All must concede then that the water comes from the mountains. Instead of trenching and getting it out of the bowels of the earth, you must gather it where it is kept, and take it out on the highest lands and distribute in that way. In that way we all can have water and abundance of it.

Senator PLUMB. These reservoirs, in order to answer the purposes of distribution, would be mainly on the highlands?

Mr. JONES. Yes.

Senator PLUMB. Would you carry the waters up on the ridges and distribute them from there to the valleys?

Mr. JONES. Yes. If you have a bird in the hand it is better to hold on to him than to let him go with the expectation that he can be caught again. If you get the sediment settled the seepage after a year or two *will* be very slight. We have to wait until we get an overflow of the *river in order* to get the ditches filled.

Senator PLUMB. Is that sediment also carried onto the soil?

Mr. JONES. Yes; it is very fertile and distributes itself very nicely. It is equal to a coating of manure.

Senator PLUMB. Is there anything else you would like to say on this subject.

Mr. JONES. It appears to me that there is only one practical way for the Government to do in getting irrigation for this country; that is, to build a large canal on each side, taking it from the base of the mountains, and taking all the water of the Arkansas River and saving it in these reservoirs. The Government would have to charge a price for it—say so much a foot—in order to protect those who have already put the ditches in.

Senator PLUMB. You mean that the Government should make the main ditches and let private individuals take out the laterals?

Mr. JONES. Yes. It would be foolish for the Government to expect to fill irrigating ditches and expect to keep them up. Let these main ditches be on the divides and let them save all the water of the Arkansas River. It has been suggested to me that the seepage would be less on them than on the bottoms.

Senator PLUMB. Would the ditches on the uplands have a steeper grade than those on the bottom lands?

Mr. JONES. No; the level of the country is generally the same.

Senator PLUMB. Would not the water scour and cut away the land?

Mr. JONES. The land is very solid and it takes an immense current to cut the banks. I have seen places where the fall is at the rate of 10 or 15 feet and yet the soil is so compact that we can not get too much fall.

Senator PLUMB. Does the porcelain lining to the ditch wash?

Mr. JONES. That does not wash. It stays in. By constructing a canal as wide as the Arkansas River you only need to have it 5 feet deep.

Senator PLUMB. Would not the evaporation be greater?

Mr. JONES. If you want to get less evaporation or seepage you will make your canal narrower; but at an expense, I would say, of $2,000 a mile, you can save every drop of water after you get it up. There would be more expense on the heavy places.

Senator PLUMB. You would be obliged to have reservoirs made at convenient points?

Mr. JONES. Yes. I can get the capital needed to develop all these ditches if we are sure of water. There is no question about that.

Senator JONES. Are you still owner of a number of those ditches?

Mr. JONES. I have some interest in them; very little.

Senator JONES. Do you sell the water-right annually or altogether?

Mr. JONES. Year by year.

Senator JONES. Have you any objection to stating the average cost per acre, to the land under the ditch, for the construction of the ditch? When you lay out a ditch do you expect to irrigate a certain amount of land? What would be the total cost of the ditch, if distributed evenly, to be paid for by the land-owners?

Mr. JONES. That would be very difficult for me to say, for I never kept any account of it in that way.

Senator JONES. Can you approximate it?

Mr. JONES. It depends on how you are fixed about machinery and everything of that sort. With the modern way of getting out water, if the lay of the country is good, and if it could be taken out without bad cuts and fills, it might be taken out at a cost of 50 cents an acre, provided

you had enough of it. It depends on the amount you get. But as to the cost of taking it out the way we have had to take it out and the amount of water that the ditches will give for irrigation, we have been letting it at $1 an acre on an average.

Senator JONES. That is $1 an acre each year?

Mr. JONES. Yes; but we have not had enough to make a dividend on that, because we have taken it out, as I say, under disadvantages and have had some experience about it.

Senator JONES. Have you any objection to stating the cost of your ditches?

Mr. JONES. I did not keep an accurate account, but I can give you the cost of a ditch 102 miles long. I have 137 miles of laterals completed with flumes and everything connected with it. It has cost me about $50,000.

Senator JONES. It is 100 miles long and cost $50,000.

Mr. JONES. Yes.

Senator JONES. What is the size of the ditch?

Senator JONES. At the head it would average about 30 feet at the bottom and about 40 feet at the top; it is 4½ feet deep.

Senator JONES. How much land could be irrigated by that ditch?

Mr. JONES. If we had water to keep it going all the time, and if people would use it judiciously and would know how to use it, I believe it would irrigate 300,000 or 400,000 acres of land. We can generally get along by one good flooding of water. That is, we can raise almost any kind of crops by having the water just at the right time. One flooding will give a man almost certainly a good crop. Some crops want more, perhaps, but two floodings, with the amount of rain-fall that we have, gives a certainty.

Senator PLUMB. Is it not usually calculated in this western country that the amount of water necessary to supply an acre of land is about a miner's inch?

Mr. JONES. The way they use water here that quantity will not do it. It will take about 1½ inches for the first year and after the first year it will take about 1¼ inches. Perhaps after using it for several years a miner's inch might do, by judicious use of the water; but our land is such that we have to flood it all over. We can not perforate or let it go by seepage through the ground, and it is better to let a big supply of water go all over. We are learning a good deal by experience here in regard to the use of water.

STATEMENT OF A. B. COCHRANE, OF SCOTT COUNTY.

Senator PLUMB. Where do you reside?

Mr. COCHRANE. In the south part of Scott County, although I have lived in the northern part.

Senator PLUMB. About how far north?

Mr. COCHRANE. About 20 miles north.

Senator PLUMB. How long have you lived where you are now?

Mr. COCHRANE. About six months.

Senator PLUMB. How long have you lived in this section of the State?

Mr. COCHRANE. This is my sixth year.

Senator PLUMB. State your idea as to the necessity for an artificial supply of water and the source from which it can come.

Mr. COCHRANE. The necessity is illustrated by this fact, nearly every section in Scott County is good tillable land, and nearly every section

has had three settlers on it in turn. Take Lake Township, for example, it will not cast 40 votes at the next election. Valley Township is the same way. Other townships are in the same fix. The people expected to make homes there and have tried, but they were obliged to go away.

We have had rain every week from the time the snow began to go away until the 1st of July, then it stopped. It has been so every season since I have been here. If the forepart of the season was good the last part was a failure. I am acquainted in the eastern, southern, and northern portions of the county, and I know there is no corn to speak of except a very few fields in the eastern or central portion of the county. In the south there is quite a wide strip where the stalks do not stand more than 3 feet high this season. Oats have done a little better than formerly.

Senator PLUMB. How is it about wheat?

Mr. COCHRANE. Where wheat has been cultivated properly it has done somewhat better. I have heard of some 17 bushels to the acre, but that is the exception. Generally it is from 7 to 12 where they have harvested and thrashed.

Senator PLUMB. How is the artificial supply of water to be got, in your judgment?

Mr. COCHRANE. I should think the water needs to come from the mountains. In the northern part of Scott County the wells are usually 100 feet deep. A large portion run from 125 to 150. In the southern portion they are from 30 to 50 feet generally, so that it would seem that either artesian water will have to be secured or it will have to come from the mountains. The land lies in good shape to carry water. There are little ridges from 10 to 20 or 30 feet above the general level. The surveys show that the water will follow those.

Senator PLUMB. Is the topography of the country such that the water can be stored?

Mr. COCHRANE. Some could be gathered in that way and brought to the lowest lands, but the general level could not be reached, I think, by water gathered off the highest ground. There are a good many farms that could be supplied perhaps by water gathered off other lands near by. But the land generally is so level that it would be difficult to reach the greater part of it. The land is pretty nearly all mortgaged. The people have been compelled to mortgage it in order to get something to live upon. If they could get water those that have gone would come back again.

Senator JONES. When did those people go there who live there now?

Mr. COCHRANE. Some of them went three or four years ago.

Senator JONES. Had there been a settlement there prior to that time?

Mr. COCHRANE. There had been a little trial about Scott Centre, as it was called. A few settlers had tried it there in 1879, I believe, but gave it up.

Senator JONES. That was the first settlement, was it?

Mr. COCHRANE. Yes, except ranching along the creeks and the prairies. They did not make any effort to do any farming.

STATEMENT OF FRED. BROWN, OF GRANT COUNTY.

Senator PLUMB. Where do you reside?
Mr. BROWN. In Grant County.
Senator PLUMB. How long have you resided here?
Mr. BROWN. About four years.
Senator PLUMB. Will you state to the committee your views regarding the necessity of an artificial water supply and the means of getting it in your locality.

Mr. BROWN. Most of our settlers came into Grant County about four years ago. They were an industrious class of people, men of indomitable pluck and determined to make a home there. Last year we had an almost total failure of crops. This year they will not cast over 200 votes in the county. Our population is reduced from 4,000 to 1,500, and we feel that something must be done. We are satisfied that we can not stay there very long unless something is done. We have deluded ourselves with the hope that turning up the soil and exposure to the sun, deep plowing, etc., would bring an abundance of moisture, but we have ingloriously failed in all that. This year is the hardest year we have had. Other years we have had enough feed for our stock. This year we will not have half enough to feed them. Everything is burnt up on the stalk. The corn is burnt up without any ear having got started, all because of the lack of moisture when we want it. Everything is very uncertain in the way of crops there and most of our people have gone.

As the gentleman who preceded me has told you, the land is mostly mortgaged, but the people will undoubtedly come back if they see they have any show. I am satisfied that Mr. Jones's idea is a good one, to bring the water from the mountains and store it in reservoirs. The utmost economy should be practiced with the water supply we have. There is enough water running down the Arkansas to irrigate 100 miles on each side, and we can not afford to waste one drop of it. In Grant County we have what seems to be a natural basin for water where Bear Creek enters the sand hills. It would be almost a natural reservoir for all our county. Bear River is a flowing stream in Colorado and the water disappears when it comes into Kansas.

Senator PLUMB. Is there anything further you wish to say?

Mr. BROWN. I might say that in the last three months there have not been more than two or three days at a time when the prairies of our county have not been burning.

Senator PLUMB. To what depth do you go for water on your place?

Mr. BROWN. From 40 to 200 feet. There is a sunk well at the edge of the sand hills where this basin enters. It is a cavity of about 150 feet across the top. From the top of the sand down to the water would be perhaps about 30 or 40 feet. There is a vast basin of water there of unknown depth. That is supposed to be the subterranean passage of Bear Creek. It goes along through the sand hills and there are a couple of lakes over there that are supposed to be a part of that connection.

STATEMENT OF D. J. BELL, OF FINNEY COUNTY.

Senator PLUMB. Where do you reside?
Mr. BELL. In Finney County, 5½ miles north of this city.
Senator PLUMB. How long have you resided here?
Mr. BELL. Six years next spring.
Senator PLUMB. Please state in your own way what is your view *with reference* to the artificial supply of water and how it is to be obtained?

r. BELL. I have no great knowledge of irrigation; only what little ve seen since I came here. Where we can irrigate we can raise as h of everything as we want. Where we can not irrigate, every- g is a failure.
nator PLUMB. Are you under a ditch now?
r. BELL. Yes; there are 30 acres that I can not irrigate because I not fixed the ditch. I have about 50 acres in which the crops are edingly fine.
nator PLUMB. Is it your conclusion from experience, then, that gation is necessary?
r. BELL. Yes. Men can not live here without it, unless they are k raisers. There are a few ranchmen scattered about the country.
nator PLUMB. What in your judgment is to be the source of sup- for this water?
r. BELL. My opinion is that the only source of supply is the Arkan- River, and in order to make a constant supply there would have to eservoirs. Without them we can not get along very well. None s get the amount of crops, even at the best, that we ought to get. will have water plentiful one week, and none the next week. Some s we will be a month without water.
nator PLUMB. How many times do you need to irrigate during the ing season?
r. BELL. My crop has been principally alfalfa since I have been . I would like to cut that every thirty days, water it once and then t, water it immediately after cutting and in thirty days it would eady to cut again.
nator PLUMB. How much water do you contract for, or how much ou expect to get according to your contracts with the ditch, per ?
r. BELL. I find that for alfalfa it is best to put in a box that carries ches of water. I contracted for 40 inches, and the contract was I should get water half the time in that box. If I could have got r half the time it would have given me an abundance, more I needed. I think a square inch, constantly running, will more than ly all the necessities for an acre of ground. A cubic inch, per- , you might call it—I mean a stream measuring 1 inch up and 1 inch ss.
nator PLUMB. Have you anything further to suggest?
r. BELL. Nothing further.

STATEMENT OF W. H. FRENCH, OF KINSLEY.

nator PLUMB. Where do you reside?
r. FRENCH. In Kinsley, Edwards County, this State.
nator PLUMB. How far is that east of here?
r. FRENCH. Eighty-five miles.
nator PLUMB. How long have you resided there?
r. FRENCH. Five years.
nator PLUMB. State the condition of things in your county with rence to the necessity for an artificial water supply, the efforts made et it, and the source from which in your judgment that supply will e to come.
r. FRENCH. There is a portion of the county to which irrigation ld be very beneficial. There is another portion of the county that ires none, and can not be irrigated. There is a range of sand hills follows the curve of the Arkansas River and goes through Edwards

County. On the southeast of these sand hills there is a valley of sandy land in which they raise crops every year and only occasionally fail to make the crop. This year corn will average from 30 to 45 bushels an acre in that valley; wheat 35 bushels an acre. On the north side of the river the case is entirely different. It is rolling upland, similar to the country here. From Garfield station (a station about 14 miles east of Kinsley) westward the crops are a failure. There is a canal that has been built from Ingalls east of here, that runs along the course of the river and ends near Kinsley or Oberly.

Senator PLUMB. Is that the Soulé ditch?

Mr. FRENCH. Yes. Last year they had a little water, and those who had land right by the ditch raised very good crops—some very good corn and large cabbages. There was a piece of land there that furnished 75 bushels to the acre. For some reason that land did not furnish anything this year. The water this year has been entirely insufficient. People have concluded that without irrigation they can not do anything, but there is no manner of doubt that if they had an abundance of water they could raise enormous crops.

Senator PLUMB. In what way could the water be supplied to that locality?

Mr. FRENCH. If the ditch had been sufficient in the first place, they would have had more water than they did have, but the trouble seems to be that the water is insufficient in the river. It is taken out of the river up in Colorado, and it never reaches down there. They are building another ditch. There is an underground flow near Dodge, and that is supposed to be enough. I do not think, however, that they will get enough water. If the water that gathers in the mountains, and in the different draws or cañons throughout this country, could be saved by means of reservoirs, there is water enough passing through the country to irrigate the country. An immense amount of water passes off by means of freshets. I have had some experience on the Pacific coast. They have there an abundance of water, somewhere in the neighborhood, for irrigation. In this country it is altogether different. We have very few sources of water.

When water is first put on the land it takes a good deal of it to go around. In the course of a few years the ground fills up, and, after that, the water goes back to the river again. In Colorado I understand that when they undertook at first to irrigate the ground it took a good deal of water, but that afterwards it did not take so much. I hardly think, however, that that will work on so extensive a scale as they think.

There are a number of draws all over this country where basins could be made at slight expense. The water might be saved and conveyed from a main ditch and other ditches. That is one thing that could be done at moderate expense. The expedient of damming up the cañons in the mountains could be resorted to. There is a large reservoir in the cañon of the Wasatch Mountains that furnishes the water for Salt Lake city. That plan might be resorted to, and reservoirs formed that would save the overflow and get an abundance of water. It looks to me as though that were the only source of supply for this country. Unless some system of irrigation is devised for the extreme western half of this State, farming, as carried on in the eastern part of the State, will not work, although it is a good stock country. They can raise some good crops here with water, and it seems to me that the people of this country should adapt themselves to the condition of the country, and raise the *crops that* the climate and soil are adapted to,

The people in our part would object to any system of irrigation that would take the water out of the country. The system of underground irrigation, if it could be accomplished, would take the water up in this part of the country. The whole county would then be dried up. It seems to me that that would be very injurious to the lower portion of the valley. I do not think, either, that it would furnish a sufficient amount of water to accomplish the object. The best plan, I think, is to store the water that comes here in the times of floods and freshets. That would probably involve the expenditure of millions of dollars, and could then be done only by the Government. If private citizens could be induced to invest money in such a scheme it would be different, but it is too large at the start for private capital to come in.

STATEMENT OF STEPHEN ROOF OF FINNEY COUNTY.

Senator PLUMB. Where do you reside?

Mr. ROOF. Twenty-five miles south of here.

Senator PLUMB. State what you may deem of interest regarding the inquiry before the committe.

Mr. ROOF. With regard to the ditch company at Ingalls, near Spearville, this is the second year of its operation. They have had trouble with their dam. This summer they had a cut-off, relieving the ditch to save the dam in case of a freshet.

With regard to irrigating this country, if the sub-water is taken out to any great extent and distributed all over the country it will be but a short time before it will get back into the soil. There is no fear of our drying up the soil by taking water from 6 or 8 or 10 feet beyond the bottom of the Arkansas River. The level of the river as far as we go, shows sand out on the plains. The depth of our wells is very close to the level of the Arkansas River so that we have here a reservoir of from 200 to 400 miles wide.

Senator PLUMB. You think, then, that if there had not been a misfortune to the mouth of that canal you would have water.

Mr. ROOF. Yes.

Senator PLUMB. Where is the new ditch that Mr. Soulé is proposing to dig?

Mr. ROOF. Is starts out east of Dodge.

Senator PLUMB. On the north side of the river?

Mr. ROOF. Yes; I think so, but I am not certain about that.

Mr. FRENCH. They are building a ditch on the south side of Dodge to run back into Dodge again. If they make a success of that, they will build another ditch below Dodge, running along the bank of the river.

Mr. ROOF. The great trouble here is from the last of June into July.

Senator PLUMB. What is the annual precipitation about Dodge?

Mr. ROOF. It is 20.77 inches; that is the average for thirteen years.

Senator PLUMB. What is the maximum?

Mr. ROOF. We have had as high as 33 inches and as low as 10 inches. If we could get the water distributed through the latter part of June and July we could complete any crop. We have completed wheat on about 6 inches of rain after the 1st of April until the cutting.

Senator PLUMB. How much did it yield?

Mr. ROOF. Five acres yielded 46 bushels; 10 acres, badly hurt by the frost, was considered a total loss, but yielded 56 bushels; 2½ miles north and west there were 18 acres that yielded 20 bushels of No. 2

wheat, prime. We have but very few general rains throughout this country. After four years' residence here I expect heavy rains, probably 3 to 4 inches at a rain, from the 1st to 10th of May. This year we did not get them in my section. We need but little help here. If by storing we could save water in the spring, and the freshets did not come down to disturb things, we would be all right. Colorado can not continue to hold this water more than a little while.

STATEMENT OF J. C. FUGATE, OF GARDEN CITY.

Senator PLUMB. You may state anything that you think will be of interest to the committee in regard to irrigation.

Mr. FUGATE. I simply desire to say a word in regard to this underground flow. We came here four years ago. I took a Burt wheel 1 foot in diameter. We got down to sand, but could not reach water until we drove through the sand. We drove through it and tubed about 1¼ inches. We watered three thousand sheep and two thousand five hundred head of cattle, beside our horses, from that well without any perceptible lowering of the water. That was out here 5 miles from the river, where we went 43 feet for water.

I also want to say one word about the water from below; there is surely a supply of it there that is inexhaustible.

STATEMENT OF W. R. GRACE, OF GARDEN CITY.

Senator PLUMB. Please give the committee any information you may have, and your views regarding the subject of their inquiry.

Mr. GRACE. It has always seemed to me that we could get water from the river here by a system of reservoirs, say a reservoir for each ditch. If you will go up on the bottom and sink a reservoir 35 to 40 feet and tap that you will find it very serviceable. I speak of water from a single ditch. From this well here at the water-works they had four pumps, but they had to quit because they could not get the water out.

There is a ditch across the railroad at this place, and they could run that full without exhausting the water. If it were so that we could get a well down and make it 100 feet square there is enough water to keep it full all the time, and there is plenty of land to be watered. If you once get the flow started it will run. By doing that we could have an abundance of water, and that, I think, would be more practical than by going across to Colorado.

STATEMENT OF ROBERT HAY, OF JUNCTION CITY.

Senator PLUMB. What is your name, occupation, and residence?

Mr. HAY. I am geologist to the Board of Agriculture for the State of Kansas, also a fellow of the American Geological Society. I reside at Junction City, Kans. For several years past I have given attention to the water-bearing strata of western Kansas and neighboring parts of Nebraska and Colorado, and have also studied the evidence of rain-fall.

Senator PLUMB. Pray tell the committee in your own way the results of your studies and observations.

Mr. HAY. There is no reliable evidence as to the rain-fall of most of this region. Seven years' observations at Fort Wallace gave an average of 19 inches per annum; this before any settlement of the country. Fourteen years' observations by the signal service at Dodge City, ending with 1887, gave an annual mean of 21 inches. Wallace is just east of the one hundred and second meridian; Dodge just west of the one hundredth meridian. Other rain-fall records are only for a single year or at most two.

In eastern Kansas rain-fall averages from 30 to 40 inches per annum. It is generally believed this rain-fall has since settlement been modified—not increased—in its distribution. There are now fewer heavy storms and a greater number of rainy days. This is attributed to the cultivation of the soil and planting of trees, which retain the moisture to be given off by the slow process of evaporation rather than by flooding the stream beds and valleys.

The active settlement of Kansas west of the one-hundredth meridian only dates from 1883; a few counties were organized as far back as 1871 and 1872. The rain records at Dodge City show great fluctuations, the smallest amount of precipitation in one year being under 11 inches. Settlers in the West already believe that the breaking of the sod has produced modification of distribution, as in the eastern part of the State, and the water is retained for a longer time in the soil. It is certain that dew falls much oftener than in the beginning of settlement. In years of the average rain-fall cereal crops—wheat, oats, maize—can be grown if the precipitation is at the right time. In eastern Kansas half the annual rain-fall comes in the four months of April, May, June, and July. Crops fail mostly by irregular—not necessarily deficient—rain-fall in June and July, and sometimes in May. If there is a week or more without rain in July the maize is in danger. Similar privation in June will damage the small grain. In western Kansas the dry time in July sometimes extends from ten to thirty days. It is in these times that the hot winds blow, and then the damage is irreparable. In reference to the growing of crops, these periods in June and July may be called the critical time. Irrigation that would water the land every five days would save them.

Senator PLUMB. From whence would you derive the supply for such irrigation?

Mr. HAY. The Arkansas River supplies abundance of water at this time. Other witnesses will testify as to the extent to which this river is available. The Cimarron can also be used.

The Smoky Hill River, the Republican, and, to a less extent, the Saline and the Solomon, though not mountain streams, may probably be used. There is, moreover, a certain formation that absorbs the rain-fall of the plains and yields it again in wells all over the high-prairie region at depths of from 40 to 200 feet. The rivers last mentioned are rivers of the plains. They do not come from the mountains, but they have permanent water below where their channels have cut through the formation mentioned. This bed is of Tertiary age; by that I mean the last of the three great periods into which geologists divide the process of world-making. These formations are probably Miocene, or the latter part of the Tertiary period. It is in places known from its appearance as the Mortar-beds; other parts are gravelly conglomerate. I have called this formation the Tertiary grit. It yields water to numerous copious perennial springs. From such springs Spring Creek, in Meade County, is kept a running stream, and about a third of its water is being now utilized to irrigate 400 acres of land. Preparations are

being made to utilize nearly the whole of this stream. Similar use may be made of the waters of the rivers above mentioned. The precise areas where such use can be made will have to be determined by surveys in three States—Kansas, Colorado, and Nebraska.

In Meade County, in the valley of Crooked Creek, north by east from the county-seat, the Tertiary grit, apparently broken up somewhat by erosive influences, has been covered up over an area of several thousand acres by an impervious, soft, bluish clay. This clay having been pierced by drills has given numerous artesian flows of excellent water, serviceable for domestic purposes, and abundant for local irrigation. One farm has three wells which yield an aggregate of 98 gallons per minute. On another farm is the largest well; it yields 66 gallons per minute. There are upwards of eighty wells ranging from the above down to 25, 10, 6, and 2 gallons per minute. Some are being used for irrigation, but none to their full capacity. Two on the farm of B. F. Cox (who was the first to obtain the artesian water), yielding together nearly 20 gallons per minute, are used to irrigate 4 acres and to supply a large carp pond. Mr. Cox considers he could successfully irrigate 10 acres if he used the water to the best advantage.

The conditions on which the artesian flow depends in this region are simple. The water-bearing stratum (Tertiary grit) has an outcrop on the edge of the high prairie where it absorbs the rain-fall. On the side of the valley slope it is covered with the impervious clay, and the wells afford it outlet at levels below the outcrop. Below the lowest wells there is a break in the covering of clay and water escapes in springs.

As the Tertiary grit is found all over the plains region, at least from the Arkansas to the Niobrara, it is probable that a repetition of these conditions might be found and other artesian flows be made available for irrigation.

At Coolidge, and near that town, both in Colorado and Kansas, there is another group of artesian wells. They are all nearly 300 feet deep. They obtain their water from a bed much older than that supplying the wells of Meade county. The formation is a sandstone of the cretatious period, known as the Dacota. To the east, this does not out-crop nearer than to the north of Dodge City. To the south it outcrops within 20 or 25 miles, but the general dip of other strata suggests that the outcrop that would take in the water yielded to the Coolidge wells should be to the northwest. This outcrop has not yet been found. It is not unlikely that other parts of the region may have artesian flows supplied by the Dacota sandstones, but the fact that the same sandstones have been pierced at Syracuse, 16 miles east of Coolidge, without such flow, shows that there is a breach in the continuity of the subteranean conditions, which indicates that the phenomena are local. It is not improbable that the local conditions may be repeated elsewhere, and areas of such repetition may possibly be found by geological examination. The largest well at Coolidge gives 100 gallons per minute, and is used for the fire-service of the city. Other wells yield 50 gallons and less, and are well situated for irrigation.

Fifty miles to the south, at Richfield, in Morton County, is another artesian well. The water comes from a depth of 600 feet, and is taken from beds of Triassic age, which are older than the Dacota strata yielding the water at Coolidge. The flow at Richfield is small, only about 6 gallons per minute, and the water is considerably mineralized, so much so as to have medicinal qualities, not enough to hinder its use for irrigation. Another well is being drilled to find, if possible, a larger flow. *The depth to the* water, and perhaps the small flow, indicate a distant

outcrop of the strata. This outcrop has not been found. It is presumably to the northwest or west in Colorado. It could be found by a careful geological examination, and probable estimates formed as to the location of other wells. In the known outcrop of Triassic or new sandstone beds to the east (over 100 miles) they do not show themselves as good water-bearing strata; but in their development at Great Bend, as shown in a deep boring there, there is one stratum that should carry water well. It does not yield water there. It might elsewhere under other conditions. The well at Great Bend gives an artesian flow of salt water from strata of Dacota age. The flow is only 6¾ gallons per minute.

At Larned is the largest artesian flow in Kansas. Besides some waste, 250 gallons per minute were measured. It is, however, highly mineralized, being a strong brine. It comes from a depth of over 400 feet, and seems to be from the top of the Triassic strata. The Larned well is so situated that it would be suitable for experimental decision of the question as to how far saline waters could be used with advantage in irrigation. Its proximity to the Arkansas River would allow of dilution of the brine to any required extent. The source of the salt is an interesting problem. If it is the salt beds below, then the water comes from a greater depth actually than is indicated by depth of the well. The wells at Great Bend and Larned are both east of the ninety-ninth meridian.

Senator PLUMB. What, in your opinion, is the value of artesian water for irrigation?

Mr. HAY. In estimating the value, due notice must be taken of their mineral properties. Usually, the mineralization increases with depth. Excluding the salt wells, this is well illustrated by the three groups of artesian wells previously noted. The Meade County wells have the purest water; those of Coolidge are next, and Richfield comes third. This is in the order of their depths. With regard to the quantity necessary for irrigation in the region between the hundredth and the hundred and third meridians, the rain-fall must be taken into account, and also the evaporation. There are at present no data for estimating evaporation. During the hot winds it must be excessive, but they last for only brief periods. It may be assumed that the annual evaporation is less than the rainfall, because the rivers of the plains do carry away some water.

Instead of using the second-foot or acre-foot, which is the unit of quantity for measuring streams used by Mr. Gilbert and others in Utah and elsewhere, I have assumed a flow of 100 gallons per minute as the basis of calculation. This is about two-ninths of the second-foot.

Our Kansas unit of 100 gallons per minute, then, would flood 5¼ acres to the depth of 1 inch in one day. Neglecting the fraction, this would allow 50 acres to be covered with water 1 inch deep every ten days. This is equivalent to a rain-fall of 36½ inches per annum. This is amply sufficient for any crops raised in this region. The rain-fall of the district may be counted on to more than supply the loss by wastage from canals. Thus, an artesian well, yielding 100 gallons per minute, may be relied on, therefore, to thoroughly irrigate 50 acres of land in the region indicated. A well of 10 gallons would suffice for 5 acres. It would be necessary in the critical period, June and July, to irrigate oftener than once in ten days. Half an inch every five days instead of 1 inch in ten days, would suffice to continue plant growth without injury, and this could easily be done. In some cases a storage reservoir might save the water of December for use in July.

Though I have shown that the flow of the artesian wells above described depends on local conditions, yet it is also true that repetition of these conditions in parts of the wide area I referred to, may be expected, and that at comparatively small cost thousands of acres may be irrigated by means of artesian wells.

Senator PLUMB. In what way can the General Government by legislation or otherwise help on this work?

Mr. HAY. It would seem reasonable that the Government should cause such geological survey to be made as would determine the areas where artesian water may be probably obtained, and, in some cases, decide it by boring. The investigations made with respect to the artesian wells previously described do not warrant the belief that the water bearing strata obtain their supply from the Rocky Mountains. The inquiry of the committee must be of great service in arousing public and legislative attention, and the irrigation survey in progress should be rapidly continued. The information it will give our people will invite capital, of course, and greatly stimulate the farmers to co-operation.

The following papers were received and ordered filed with the Kansas testimony. The committee then adjourned.

FURTHER STATEMENT OF J. W. GREGORY, OF GARDEN CITY, IN RELATION TO THE ARKANSAS RIVER UNDERFLOW.

While a certain degree of success in farming has been found possible west of the one hundredth meridian in the southwest, still we take it for granted that all will concede the proposition that irrigation has proven a necessity—an absolute necessity—to general success.

We can not afford to spend the best years of our lives attempting to open this region to agriculture, without the assistance of a certain water supply. If such a system can be secured, we wish it at once. To the pioneers who have borne the hot wind and the blizzard, driven out the buffalo, the wild horse, and the coyote, taken the risks and conquered the wilds, belong of right the fruits of their labors. If they are to enjoy the benefits of the development of this region, it must be accomplished without delay. Every resident of southwest Kansas and southeastern Colorado knows this.

Now can any practical system of irrigation be speedily secured?

In the solution of such a question as this the first thing and the matter of greatest difficulty is to get rid of the impracticable plans which inevitably will be advanced.

Drawing upon the head waters of the Missouri and the Yellowstone by an immense canal which shall skirt the mountains, crossing streams and ravines in its course, has been suggested. While this might be done at some future time, the immensity of such a work and the time and incalculable expense necessary render it impossible within a period which would make it worth while for us to think about it as a practical solution of our present and pressing difficulties.

Artesian wells have been found in parts of this region. Do they furnish the solution to the problem? Let us test the matter as far as we can. It is better to lean upon no staff at all than upon a broken one, because leaning upon a broken stick insures a fall. It is better that we should give up the battle at once and seek new fields of labor than that we should spend our time and strength upon that which will yield us in the end only disappointment and defeat.

Henry Stewart, civil and mining engineer, the pioneer writer upon the subject of irrigation, says this of artesian wells:

"The idea that artesian wells may be made a source of supply for completely irrigating large tracts of land, if ever held by any over-sanguine persons, must be abandoned. For partial irrigation they may be made available, but the quantity of water needed for the irrigation of a few acres of land only, in localities where there is no summer rain-fall, as upon our western plains, is far beyond the capacity of any artesian well to supply, unless it be one of extraordinary volume.

"It is very important that the quantity of water needed for irrigation should be accurately estimated. A mistake in an estimate may lead to the construction of inadequate works and the useless expenditure of much money. Estimates generally *err upon the side* of insufficiency rather than otherwise, and much error has been *spread abroad by* persons and journals having considerable influence. * * *

"An artesian well 6 inches in diameter would give a stream of 28 square inches, and would deliver 32 quarts per second, if the flow were at the rate of 4 miles an hour. Such a well would furnish an inch of water per day for 28 acres, or an inch a week for 196 acres, which would be a very insufficient quantity to irrigate dry, open soils in places where the climate is arid. The cost of such a well would be at least $5,000 to $10,000, or more than the value of the land when irrigated."

These statements, coming from a recognized authority upon irrigation, are corroborated by our experience. Consider what the successful wells in southwest Kansas have cost, figure out what they will irrigate—even at the most liberal estimate—and it will be seen that they will probably cost far more than the land they will irrigate is worth; because, further, in considering the development of the country by such means, the uncertainty of striking water must be taken into consideration. At Garden City, at Syracuse, at Santa Fé, at Springfield, and other places are expensive "dry holes." These things will, of necessity, be taken into consideration by capitalists—must be considered by any one, when figuring upon the chances of irrigating from artesian wells. Beside, the multiplication of such wells in close proximity soon causes all to cease to be flowing wells and become only pumping wells. This is proven at Denver and elsewhere.

Let it not be supposed that we would oppose the sinking of all possible artesian wells. We all must rejoice at every such development. Each such thing helps at least a little; but southwest Kansas contains about 9,250,000 acres of land, nearly all of which is cultivable; and as not less than 30,000 artesian wells would be needed to irrigate the whole, even if the system were successful, costing in the neighborhood of three hundred millions, it is evident that, for any system that shall be of general benefit, we must look further while being glad to have the help of all such wells as may be had.

"Storage reservoirs" in the mountains and the conservation of "storm waters" have been greatly urged of late as the means of providing the necessary water supply. That storage reservoirs for the conservation of the mountain waters will be worth all they can reasonably cost to those regions near enough to the mountains to be benefited is certain. Neither will the citizens of southwest Kansas grudge the expenditure of the estimated cost of fifty millions by the Government, or twice as much if necessary, to secure storage reservoirs which shall save the heavy precipitation of the mountain ranges and apply it to the soil—both for the benefit of those who may use it for irrigation, and also of those on the lower courses of the great rivers, who will thus be relieved of a vast surplus flow of water, which becomes, year by year, a greater menace and danger to them.

But what will such storage reservoirs do for us? Let us take account of a few "pointers." Maj. J. W. Powell, chief of the U. S. Geological Survey, estimates that when all possible sources of water supply for purposes of irrigation are utilized, but 25 per cent. of the lands requiring irrigation can be served with water. This is not encouraging to people so far from the mountains to depend upon such a source of supply. On each side of the Arkansas River, in Colorado, lies a vast plain of rich land yearning for irrigation. Roughly estimated, there are not less than 8,000,000 acres of land in these two areas. If but half of it is susceptible of irrigation, that would make 4,000,000 acres which must, according to Senator Plumb, eventually be satisfied before Kansas can expect to use any of the water coming down the Arkansas, whether it be stored melting snow or storm waters. If the Arkansas River should furnish a stream of water 1,200 feet wide and 4 feet deep, flowing at a speed of 3 feet per second for one hundred days in each year (it has not furnished one-fifth that amount this season), that would furnish but two practical irrigations per year to 2,500,000 acres. As a matter of fact, the average total water supply of the Arkansas River, for the next five years, at least, will not, if all utilized, furnish safe and reliable irrigation for more than 1,000,000 acres of land each and every year, and there are already ditches constructed and projected in Colorado covering land sufficient to use at least all of the practical supply. The fact is, eastern Colorado, adjoining Kansas, is as much in need of a prompt and effective solution of the problem of a water supply as is western Kansas. Stewart, the authority already quoted, says of the Arkansas valley:

"The nearest crest of the water-shed on the north side of the river is 45 miles distant, on the south, it is much more distant. If we calculate a territory only 90 miles wide and 500 miles long, depending upon this river, it would contain 28,800,000 acres, requiring 1 cubic foot per second per 100 acres, 288,000 cubic feet per second. To supply this there would be required a river nearly 2 miles wide and 10 feet deep, flowing 2 miles an hour, with no allowance for loss by evaporation and percolation. The Arkansas is not one-fifth of this capacity and could not supply one-tenth of the territory."

What of the storage of storm waters that fall on the lands in which we are interested? Here is probably the worst impracticability yet suggested.

To begin with, we lay down this proposition: That there is not enough surplus storm water, collected or wasted, in all southwest Kansas in twelve months to fur-

nish practical irrigation for 5 per cent. of the land. Then more than half of all that is collected, collects in basins where it can not be utilized for irrigation, and any reservoirs constructed to save the remainder would cost many times what the land they would irrigate would be worth. Supplemental to some other water supply, they would be of great value, well worth what they would cost, because they would supply the seepage and evaporation over a large area, thus making a large net gain in the water supply. It is only that such a supply alone would be practically exhausted by the inevitable waste of evaporation and percolation that renders it useless as a sole source of supply.

These propositions are fully demonstrated both by facts which are familiar to all residents of the Southwest, and also by practical test.

It must be conceded that storm waters to be stored and used for irrigation must be caught in something of the nature of what we call in this part of the country a "draw," that is, it must be a depression with an outlet which may be closed by a dam to hold back the waters, and through which they may afterward be let out as needed upon the land below. Waters caught in a deep, bowl-shaped basin, without an outlet, are more inaccessible for irrigation than if at the bottom of a well. Where, then, can be found draws which may be converted into storage reservoirs for storm waters? Only along a narrow strip of land north of the river in Hamilton and Kearney, Gray and Ford Counties, and probably in still narrower strips of rough land along the Cimarron, the Pawnee, the Whitewoman, and the Beaver. Not 10 per cent. of the total area of this region could thus be utilized for the construction of such storage reservoirs, and not only would the waste in such draws from soakage be very great, on account of the nature of the formation, but the water would have to be carried to such a distance in order to get it out upon land susceptible of irrigation, that it would be practically used up in transit. There is no part of the country offering such advantages for reservoirs of this kind as the northwest part of Ford County and northeast Gray, and here the Eureka Canal has had a large number of such reservoirs in use for the past two or three years. The ditch and reservoirs were constructed by the Gilbert Brothers, who have had charge of the work and watched the development and operation of the works from first to last. Mr. G. G. Gilbert, being asked as to the supply of storm waters collected in these draws, fully corroborates the foregoing statements as to the inadequacy of such reservoirs as a primary source of supply. Being finally asked how much land he could depend upon irrigating from these storage draws, unaided by water from the river or some other source, he answered promptly: "None whatever."

As an ounce of practical and intelligent experience is worth a ton of untested theory, we regard this as settling the status of storm storage reservoirs in this region. As accessories, to make up for the various wastes of evaporation and percolation, they will be valuable. Without an additional source of supply, they are absolutely without practical value.

As for digging out little 5-acre ponds all over these level prairies, as has been gravely advised, there is not one of our farmers but can say at once that such holes might as well be dug in the crest of Chimborazo or the heart of Sahara for all the practical good they would do us, unless there is first some source of supply aside from the rains. They would simply be dry, unsightly, costly holes, useless and in the way. The storm waters which fall upon more than nine-tenths of the area of southwest Kansas do not run off into streams. They go straight down and up. Ask a resident of Finney County how much rain-water gets into the river from the entire area of the county, aside from what falls upon the stream and its immediate banks, and in one small draw in the eastern part of the county, and he can truthfully answer, "Not a bucketful."

The entire county of Haskell, with adjacent parts of Grant, Finney, Gray, Seward, and Meade compose a vast plain with an area of about 15,000 square miles in which there is not a single stream, nor place for one. None of the rain-fall flows off from it. The major portion of every other county in the entire district is similarly conditioned. North Finney, Kearney, and Hamilton and south Greeley, Wichita, and Scott contain an almost unbroken plain still larger than the above. In the adjacent parts of Colorado the same vast undrained areas are found. Whenever there is a sufficient rainfall upon these plains to fill a 5-acre pond upon each 40 acres with surplus surface water, the ponds will not be needed, for there will be rain enough to dispense with irrigation and replace it with a system of drainage.

Can we then secure a supply of water sufficient to irrigate this vast and rich region by the help of the artesian wells and storage ponds? Let us see.

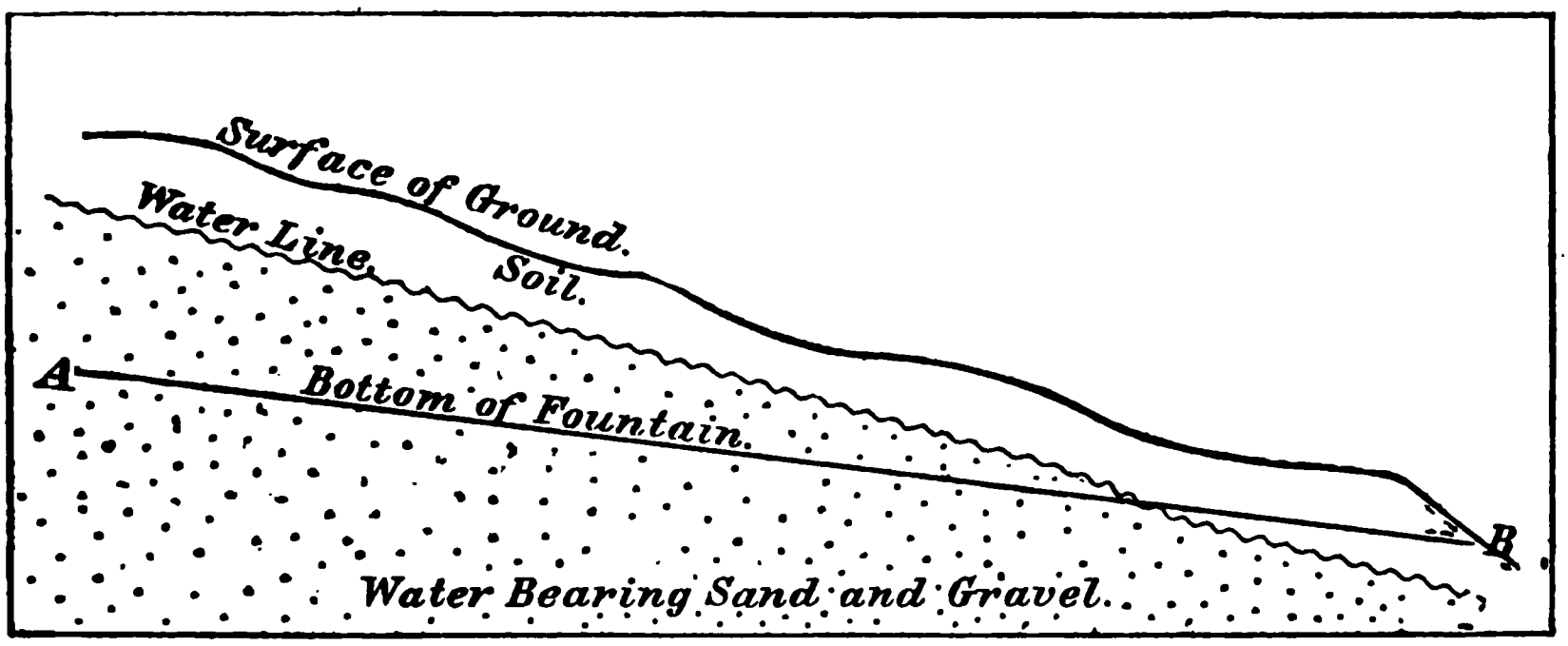
Underlying the whole Arkansas Valley is a vast sheet of water of unknown average width and depth. Every well in the valley and within a few miles upon the upland—except in a few localities—penetrates the "sheet water." From Dodge City, Kans., to La Junta, Colo., the Santa Fé Railroad has fifteen large wells. They all *penetrate the* sheet water and none go through it. So says Mr. R. A. Stein, superintendent of the western division of the water service. The water-works well at

Garden City goes into the sand to a depth of 11 feet and soundings to a depth of 25 feet more did not "touch bottom." The experimental boring made here at Garden City in 1888, passed through a depth of 320 feet of water, soaked sand and gravel.

P. W. Conyers's well, 17 miles north of the river in Finney County, strikes the sheet water and so does the well of S. G. Morris, 15 miles south of the river in Gray County. These are only given as examples. Scores more might be mentioned. J. S. Humphrey, a practical civil engineer, who has given some years to the study of the matter, estimates that the sheet water extends from the south side of the sand hills, 10 miles south of Garden City, to a point at least 60 miles north. W. E. Trull, who was for a long time city engineer, and closely observed the same matter, is convinced that the sheet water is not less than 30 miles in width. It would not be reasonable to suppose that it did not at least extend to the northern edge of the river valley, and to the south side of the sand hills which skirt the river on the south, which would make an average width of at least 12 miles. What may be the average depth of this vast reservoir of sand and gravel saturated with water is not determinable from the slender data at hand, but it is safe to assume that it is more than 20 feet. That a steady current flows eastward through the porous strata of sand and gravel is a well established fact and undisputed. It has been observed for years and by hundreds of people. In many wells the current is plainly perceptible, and in all, any chance bit of wood or handful of chaff or leaves blown in by the wind, floats to the east side of the well.

All these facts are of utmost importance to us, because they prove that, underneath our feet, a broad and deep stream of water slowly passes down the slope, compared with which in volume the visible stream is as an infant to a giant. Let us gather an idea of the capacity of this subterranean stream to supply us with water.

Carefully conducted experiments, made in the past few days, show that a single square mile of this sand, 20 feet deep, contains about 209,000,000 cubic feet of water, enough to flood 19,200 acres of land to a depth of 3 inches. While it would be practically impossible to drain any given area of these substrata completely, it is well known that they yield up their waters with great readiness. The Garden City Water-Works well, before referred to, is but 25 feet in diameter and penetrates the water-bearing stratum but 11 feet, and water can enter the well only at the bottom, the walls being of rock laid in cement, yet it will furnish 800,000 gallons of water per day. If, then, the half of these subterranean waters can be utilized to a depth of 10 feet over an area of 5 miles wide, enough water can be obtained to flood one-half of the land for 40 miles on each side of the river to a depth of 3 inches. In practical use, if one-half the land can be irrigated, the rest will be included in pastures, roadways, high places, etc.



This diagram represents a cross-section of a 2-mile stretch of river bottom land in which the slope of the surface (which is 7½ feet per mile) is purposely exaggerated in order to make the method of obtaining water easily perceptible to the eye. The upper irregular line represents the surface of the soil, the wave line next to it representing the surface of the saturated sand and gravel which lies from 1 to 2 feet below the top of the ground and extends down to a great depth. Let the line *A*-*B* indicate the bottom of an irrigating fountain, and it will be seen that water which will rush into it, as into a well, at *A*, will readily run out upon the surface at *B*.

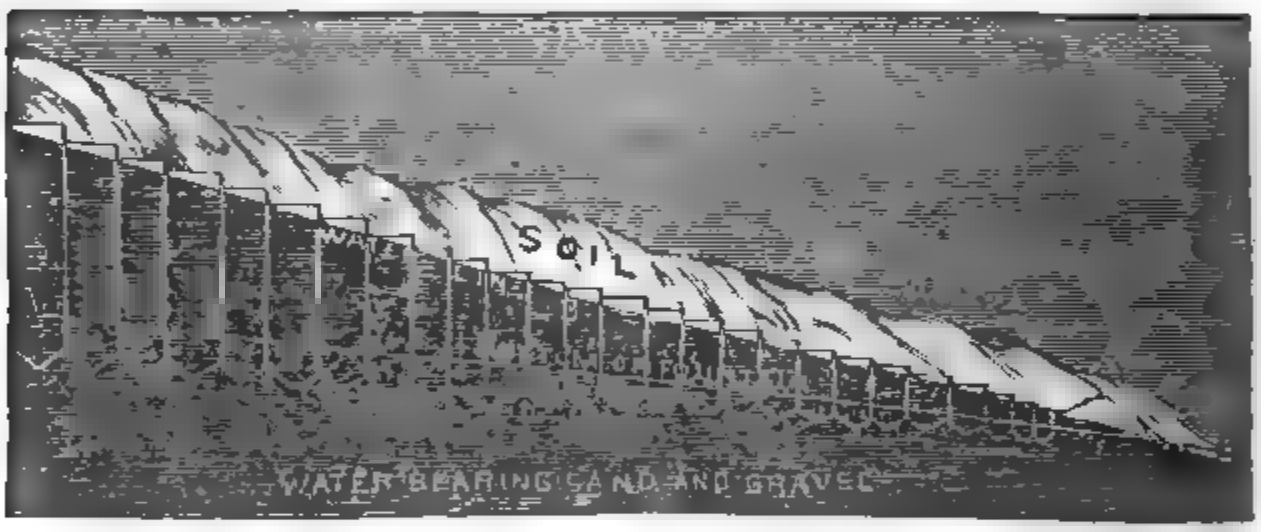
Can this water supply be obtained; and if so, how?

As is well known, this valley and adjacent plains have a slope to the eastward of 7½ feet per mile. In the river bottoms, the surface of the soil is but 3 feet above the surface of the underlying water over large areas. Great pools or fountains can be opened into this subterranean water supply and the accumulating waters run to the surface in ditches having a fall of, say, 2 feet per mile. The accompanying diagram illustrates the method.

The surface of the ground and the surface of the underlying water are indicated. Let the line *A-B* represent the bottom of an open fountain, having a fall of 2 feet per mile, and it will readily be seen that water from 10 feet below the water line at *A* could be discharged into a ditch 2 feet deep, only 2 miles distant at *B*. The bottom of the fountain at *A* would be 13 feet below the average surface of the river bottom lands. To discharge water from that point into a ditch 2 feet deep at *B* would require it to be raised 11 feet. This the difference between a fall of 7½ feet per mile and a fall of 2 feet would accomplish in 2 miles.

A fountain or pool thus excavated, 40 feet wide and a little more than 2 miles long, gradually deepening to a depth of 10 feet below the water-line, would have an area capacity one thousand times larger than the Garden City well. If it could supply a proportionate extreme output of water, it would yield 800,000,000 gallons of water per each twenty-four hours. And while it could not be expected that one-half such proportionate yield could be had steadily, yet if it should yield a supply of but 10 per cent. as large in proportion it would produce water enough to cover 1,000 acres per day to a depth of 3 inches, making a total irrigation capacity of 30,000 acres per month, or 360,000 acres per year. Granting a loss of nearly one-half of this supply from soakage and evaporation in ditches, fields, and storage reservoirs, still two thorough irrigations per year would be assured to 100,000 acres of land from such a fountain. From data already obtained, we feel justified in stating that such a supply, including the cost of making fountain, canals, storage reservoirs, etc., including all ground and right of way for same, can be obtained at a cost of less than $100,000, or not exceeding $1 per acre to be irrigated. Should time show that the cost will be even ten times as great, it will still be below the average cost of depending upon "storage, storm, and torrential" sources, and will pay enormously.

HOW THE WATER IS OBTAINED.



In this drawing, which represents a longitudinal section of part of a "fountain," the slope of the land is exaggerated in order to make the method of obtaining water plainly apparent to the eye. Let the drawing represent a stretch of 2 miles of Arkansas River bottom, which has an eastward fall of 7½ feet per mile, hence, the surface at C is 15 feet higher than B. The underlying bed of water bearing sand and gravel, averaging 3 feet below the surface, is indicated. If the fountain be excavated so that the bottom will have an eastward fall of 2 feet per mile (indicated by the line A B) the bottom will be 11 feet below the surface at C, and 8 feet below the water-line, so that the water which rushes into the fountain from bottom and sides will readily flow out upon the surface of the ground at B. This plan is in operation in several places and is thoroughly successful. The drawing shows, in outline, sheet piling, which is used as one means of walling such a fountain.

Of the objections that may be interposed to this theory of obtaining water for irrigation, we will here notice but one: "Will not such a pool fill up with sand?" The numerous large wells so long in use along the river show that curbing at the sides is required, but that the sand will not fill up from below.

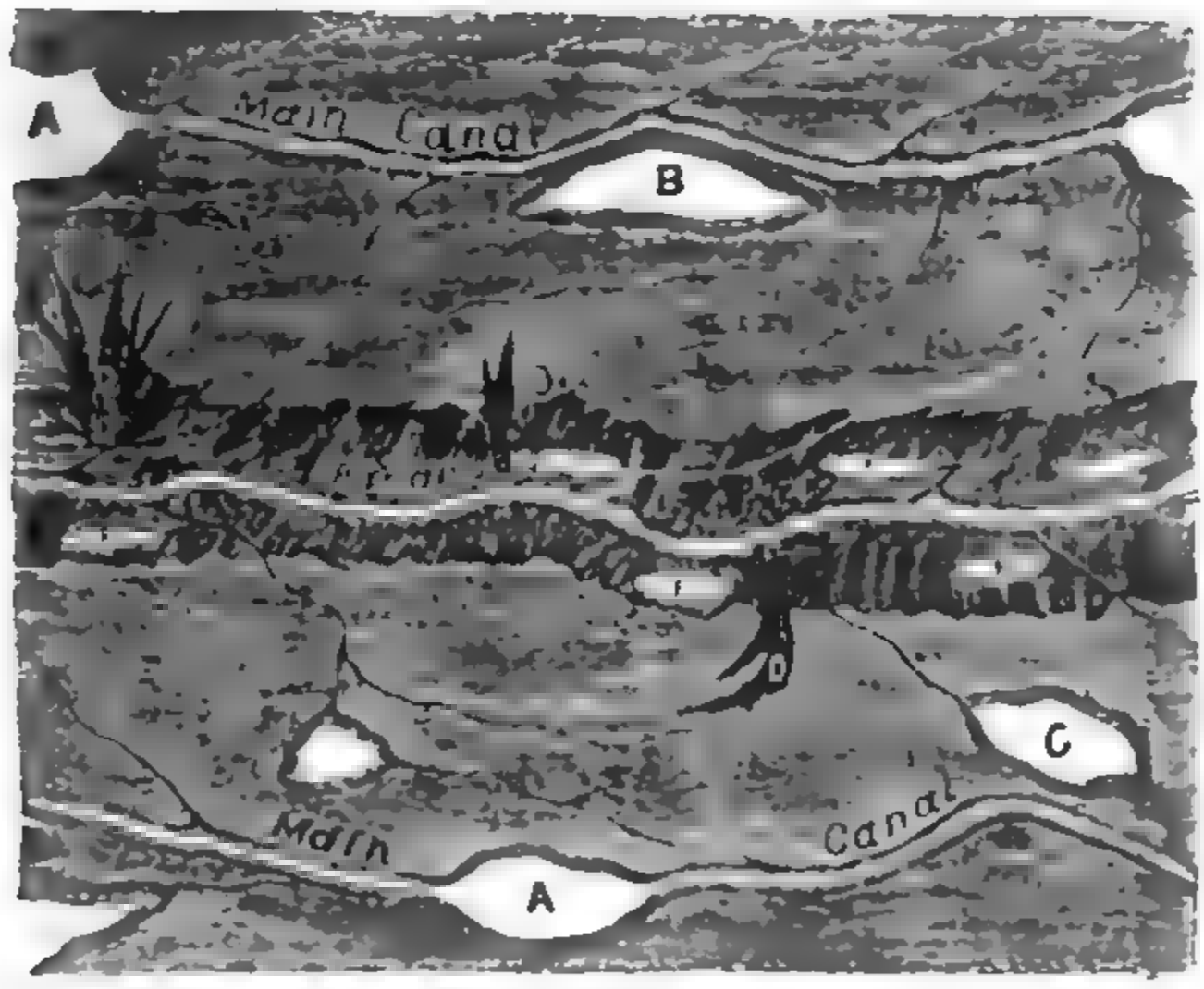
All the points as to abundance, steadiness, permanence, and cost of the supply have been considered, and we are prepared, we think, to meet all possible objections with facts, figures, and demonstrations that can not be controverted.

We may as well meet the facts and face them. Nothing can be gained by shutting our eyes to the inevitable and clinging to exploded theories. To do so is to invite disaster and bitter disappointment. Without the utilization of this vast underflow, artesian wells, the rivers, ditches, and storage reservoirs will only starve us on broken promises and hopes deferred. By prompt and united effort, all southwest Kansas and southeast Colorado (whose necessity is just as great) may so add to the present resources for water as to make the future one of certainty and most abundant success. And such a demonstration in the Arkansas Valley will lead to the devel-

opment of similar vast and heretofore unused resources for irrigation in other parts of the West.

To secure speedy and systematic development will require governmental attention. A central system of main canals and storage reservoirs should be laid out upon the highest ground on each side of the Arkansas River, these twin systems reaching well up into Colorado. Into these, any number of great fountains, opened into the saturated substrata, may be made to pour torrents of water the year round, keeping them full and ready for service at all times. Neither long delay nor great expense will be required. With the work thus laid out and systematically begun, private capital may soon be brought forward to take up the work in a way that while it will pay the capitalists, will also give the greatest benefit to the sturdy pioneers who are entitled to greatest consideration. Without governmental action, the development will undoubtedly take place in time; but in a hap-hazard and uncertain fashion and with such delays as will result in incalculable loss to the people.

How can it be done? A large main canal should be provided on the highest ground on each side of the Arkansas River, reaching from the mountains, or nearly so, in Colorado, past the one hundredth meridian in Kansas; these to be kept upon the highest land and to be connected with available storage reservoirs, thus making two grand chains of storage canals and lakelets, reaching clear across the said region. Then open supply pools from the underflows and lead the waters to these storage systems, where it could be made available for all parts of the land needing irrigation. A supply once stored, no part of the great plains need ever be without its ample supply of water right at hand. The accompanying rough sketch illustrates the method suggested. While storm waters, surplus from the mountains, and the flow of artesian wells would all land their aid, it must be apparent on the most casual observation



NOTE.—This view illustrates the method by which the underflow of the Arkansas Valley may be utilized to irrigate the lands for many miles on each side. By means of fountains opened on each side of the river alternately (as at F F) not only the underflow water, but all that coming down the river, all the surplus storm waters caught in "draws" or ravines (as at D D), and all surplus from artesian wells (as at W), may be stored so as to have an abundant supply always ready for use in all parts of the region to be irrigated, by means of systems of main storage canals and storage basins. These main canals should be constructed on the highest land on each side of the river, utilizing for storage purposes such large depressions as fall in the line of a main canal (as at A A), or to one side (as B B), or on the line of a supply canal (as at C). A glance at this plan will show how necessary it is to a general development of irrigation in a large scope of country to have all development made a part of a general system, under general regulations. As the plains are in reality a vast hillside, such a system of storage canals and reservoirs will furnish steady water-power to an incalculable amount; and this power, by means of electricity, may be transmitted to distant points.

that the steady gush of the inexhaustible waters of the underflow, day and night, the year round would be of vastly greater significance. We only need refer *en passant* to the immense amount of water power such a system would develop—sufficient to cover the land with factories, and heat and light the homes of the people by electricity. With such a system of water supply once developed, this valley of the American Nile will support in comfort at least thirty millions of people.

It is the duty of the Government to take hold of this matter at once for a host of reasons. Private capital would develop the whole in time, but piecemeal and in a desultory and unsystematic way. Some favored localities would be crossed and recrossed by a superabundance of ditches, crowding and interfering with each other, while other portions would be neglected wholly or for long years. The cost to the people in delay and overcharges would be more than the entire cost of the system. The interstate feature can be handled only by the national Government.

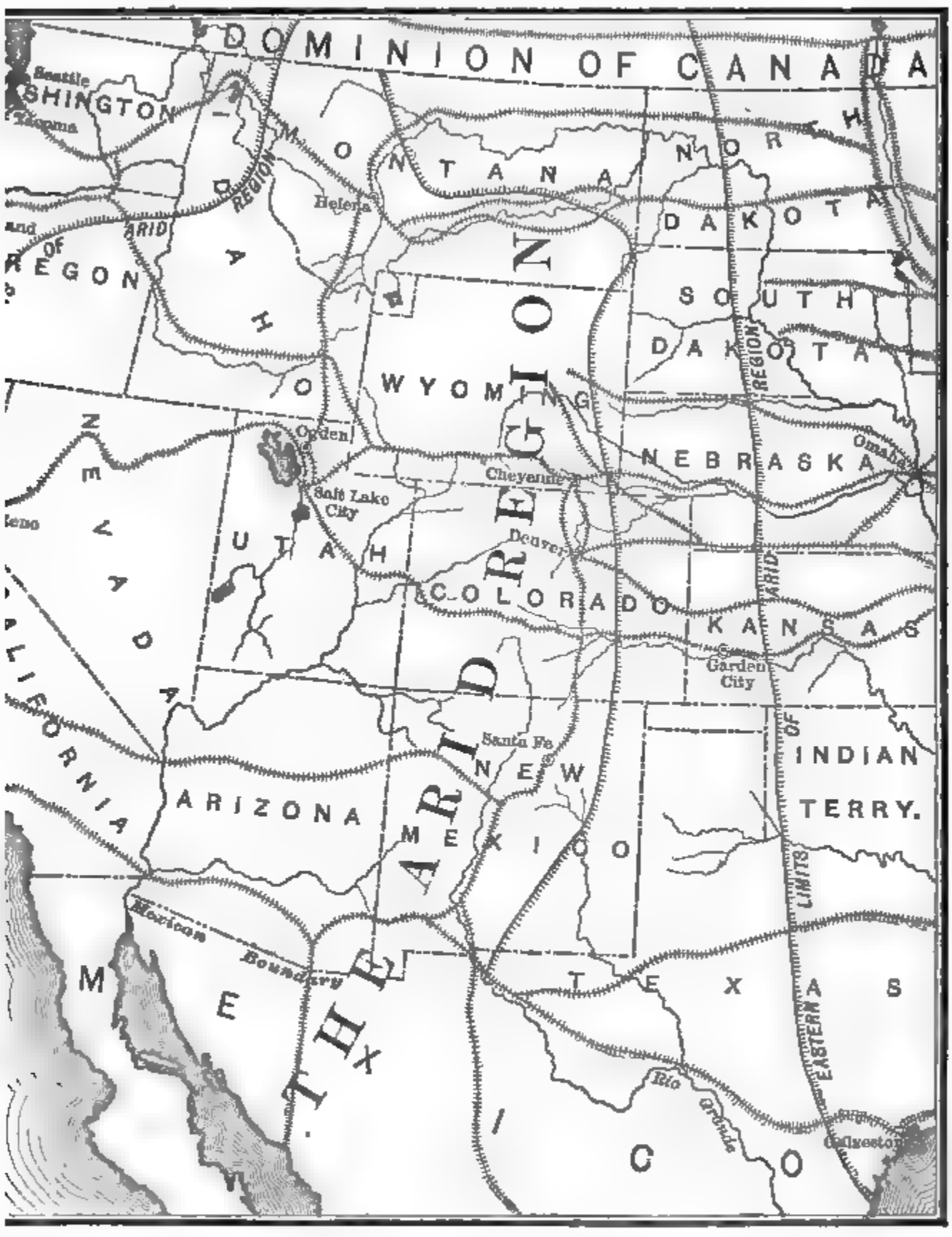
HOW WATER RUNS UP HILL.

NOTE.—Many people find it difficult to understand how water, used for irrigation, runs from the Arkansas River, which is in a valley, out upon the highest upland. It is the rapid slope of the surface of the plains which makes this an easy matter. The general surface falls 7½ feet per mile from west to east. If a ditch be cut from the river, as shown in the drawing, with a fall of 1½ feet per mile, it will climb 6 feet higher up the slope every mile, and yet have a good current.

Not only would national assistance insure the speedy and systematic development of the whole, but it would justify a proper regulation of the cost of water to the consumers.

It would not be necessary that the entire development should take place in a year or two, even if such a thing were possible, but so much would be assured from the first that any part, whenever constructed, would be in harmony with the final whole, and the waste of time, energy, and money be reduced to the minimum.

A MAP SHOWING THE UNDERFLOW'S CHIEF DOMAIN.



E. This map shows the generally accepted boundaries of what is known as "the arid region," and en the two shaded lines on the right is shown the strip of country which will be most benefited by the pment of the vast subterranean sources of water supply for irrigation, which may be tapped and d in hundreds of places, not only in the region thus outlined, but throughout the entire territory in irrigation is needed. The lands which will thus be furnished with irrigation are in very large pro- n smooth as to surface, possessing soil of great depth and exceedingly rich, and having a fine climate. are too far from the mountains to secure a reliable supply of water from torrential sources, and, at ime time, they already contain many settlers who have been tempted, or gone mistakenly, beyond undaries of humid areas. Hence, the underflow will not only furnish to many million acres of rich he only sure means of irrigation, but will turn the sorrow of many thousand toiling settlers into joy ing to their arid homesteads the means of the highest degree of fertility and a certainty of much greater s in farming than can be secured by natural rain-fall.

STATEMENT OF CHARLES MANKART, DIVISION ENGINEER UNION PACIFIC RAILWAY.

There are no artesian wells on the Kansas Division. Our water supply is obtained from wells varying in depth from 13 to 260 feet, and from running streams. I am unable to ascertain the cost of the wells as the motive power and construction department has no record of their cost, neither is there any record in the superintendent's office.

I send herewith a statement giving description of wells, quality of water, etc., at our water stations between Wakeeney (just east of one-hundredth meridian) and Denver.

Union Pacific Railway, Kansas Division. (Main Line.) Description of water supply west of the one-hundredth meridian.

Location.	Source of supply.	Diameter.	Depth.	Quality.	Nature of supply.	
		Feet.	*Feet.*			
Collyer	Well..	*14 †20	100	Fair	Good	Standard tank, 16 by 24, capacity 50,000 gallons.
Buffalo Park	....do ...	20	110	Good ...	Medium.	Do.
Grinnell	....do .	*10 †16	130	....do ...	Good ...	Do.
Oakley	....do .	‡14 †20	112	Fair	....do ...	Do.
Monument	....do ...	16	81	Good ...	Medium.	Do.
Lisbon	....do ...	10	30	Bad.....	Good....	Do.
Wallace	Creek ..	.....	.....	Fair	....do ...	Do.
Weskan	Well....	12	130	Good ...	Poor....	Do.
Cheyenne Wells..	....do ...	§6	260	....do ...	Good ...	Do.
Kit Carson	....do ...	12	41	Poor....	....do ...	Do.
Aroya	....do ...	20	22	Very bad	....do ...	Do.
Mirage	....do ...	16	13	Fair	....do ...	Do.
Hugo	....do ...	24	26	Bad	....do ...	Do.
Lake	....do ...	15	21	Fair	....do ...	Do.
Agate	....do ...	24	80	Bad.....	....do ...	Do.
Deer Tail	....do ...	10	16	Poor....	....do ...	Do.
Byers	....do ...	20	34	Bad.....	....do ...	Do.
Watkins	....do ...	10	16	Good ...	....do ...	Do.
Magnolia	....do ...	10	34	....do ...	....do ...	Tank 14 by 16, capacity 13,200 gallons.

L. AND C. DISTRICT.

		Inches.	*Feet. In.*			
M. P., 166.5, near Hoxie.	Sand Creek.	.....	.....	Good ...	Good ...	
Menlo	Well....	‖7	133 7	....do ...	....do ...	
Colby	....do ...	‖7	119 8	....do ...	....do ...	

*Top. †Bottom. ‡First 70 feet. §6-inch pipe. ‖ Pipe.

STATEMENT OF WATER SUPPLY BY ATCHISON, TOPEKA AND SANTA FE RAILROAD COMPANY.

[Addressed to Mr. Hinton, engineer expert with the committee, by A. A. Robinson, second vice-president.]

In compliance with request for information concerning the water supply on the Santa Fé System west of the one hundredth meridian, for use of the Senate Committee on Irrigation, I take pleasure in inclosing the following:

Brief statement of our water supply.

Copy of analyses of certain waters.

Blue print of condensed grade profile. (As the profile does not show the lines recently constructed I suppliment it with a list of elevations above sea of controlling points.)

I regret I can not furnish you with profiles of all the new lines, but we have no *condensed* profiles, none but on the large scale of 400 feet to 1 inch, to copy which would *require too long* a time.

MIDDLE DIVISION.

The only part of this division lying west of the one hundredth meridian is on the Great Bend Extension of the Chicago, Kansas, and Western Railroad, lying west of Ness City, and covering a distance of 91 miles.

There are four water stations on this part of the line—located at Beeler, Dighton, Modoc, and Crisby.

At Crisby the source of supply is a well 97½ feet deep, and furnishing 2,000 gallons per hour.

At Dighton there is a well 18 feet in diameter and 65 feet deep, and at Modoc the well is 16 feet diameter and 102 feet deep. At Beeler the source of supply is a small stream which has been dammed. From this dam to the tank there is a pipe-line 1,100 feet long.

At each point steam power is used.

SOUTHERN DIVISION.

The only part of this division lying west of the one hundredth meridian is that part of the Panhandle extension within the State of Texas.

Water stations are located as follows: At Clear Creek, 7 miles west of Glazier, where the water is pumped by steam from the creek. At Miami, where there is a well 51.5 feet deep, which furnishes 40 gallons a minute. West of Codman, where water is pumped by steam from the creek. At Panhandle City considerable time and money has been expended to secure an adequate water supply, but the result has not been satisfactory. A well was dug and drilled to a total depth of 560 feet without getting a sufficient supply. The company now hauls water from the Miami tank.

In a test well sunk at Panhandle City, water was struck in sand at a depth of 341 feet. The water rose 18 feet, with a flow of only 5 gallons per minute or 7,200 gallons per day. At Glazier a well has been sunk for section house uses, and good water obtained at a depth of 20 feet.

WESTERN DIVISION.

From Dodge City to Cañon City—From Pueblo to Denver.

From Dodge City to Cañon City the railroad lies in the valley of the Arkansas River, and, with the exception of Pueblo and Coolidge, the water supply is obtained from wells varying in diameter from 18 to 30 feet, and in depth from 15 to 40 feet. Steam is the power used at all of the water stations with the exception of Syracuse, Prower's, and Taylor's, where windmills are used.

At Pueblo water is obtained from the city water-works company, which company obtains its supply by pumping direct from a reservoir which is filled by an open ditch from the Arkansas River.

At Coolidge water is obtained from an artesian well recently completed. This well is almost 300 feet deep, and the flow is something like 100 gallons a minute.

The following are the water stations between Dodge City and Cañon City: Dodge City, Cimarron Pierceville, Sherlock, Lakin, Kendall, Syracuse, Coolidge, Granada, Lamar, Prower's, Caddoa, Las Animas, La Junta, Carlin, Nepesta West of Boone, Pueblo, Taylor's, and Clelland. Total, 20. Between Pueblo and Denver there are the following water stations, viz: Piñon, Fountain, Colorado Springs, Pring, Castle Rock, Sedalia, and Denver.

At Colorado Springs water is obtained from the local company. At Castle Rock water is pumped from an open box sunk in the bed of East Plum Creek, and at Sedalia the water is pumped from a bored well, the well being 300 feet deep, and the pump placed at a depth of 120 feet from the surface.

At the other stations above named water is taken from wells, which are of the same class as those in the Arkansas Valley. The flow of water, while not so great as in the valley, is sufficiently ample for the company's present needs.

NEW MEXICO DIVISION.

From La Junta, Colo., to Wallace, N. Mex.

At Timpas and at Iron Springs there are wells located on the bank of Timpas Creek, a steam-pump being used at the first-named and a wind-mill at the last-named station. At Thatcher there is a well located some distance from the railroad, with a pipe line extending from the well to the tank. The supply has proved so meager that the well has been practically abandoned, and now water is hauled from Trinidad. At

Hoehne there is a well on the bank of the Purgatoire River and the power used is both steam and wind. At Trinidad the supply is obtained from the local company. At Starkville and Morley water is obtained from Clear Creek and conveyed to the tanks through iron pipe. Springs at the head of Clear Creek are the source of supply and one or more dams serve to collect the flow from the springs. At Lynn water is obtained from wells and springs located at various distances, none exceeding a mile, and by pipe lines conveyed to a pressure tank at the railroad. At Raton, the site of extensive shops of the company, a well on Raton Creek and various springs on the high ground surrounding the town furnish the supply. Steam is used to force the water from the well, while from the springs gravity does the work.

At Otero, Dorsey, and Maxwell City the supply is obtained from wells on the bank of Red River, steam being the power at Otero, while wind-mills are used at the other two. At Springer there is a well near the Cimarron River, with both steam-pump and wind-mill. At Colmor we have a well and wind-mill. At Wagon Mound springs are the source of supply and gravity does the work. At Shoemaker's a steam-pump forces the water from a well on the bank of Mora River. At Las Vegas water is obtained from the local company, whose source of supply is the Gallinas River. At Bernal gravity brings the water from several springs. At San Miguel and Rowe wells are located on the bank of the Pecos River and steam furnishes the power. At Lamy gravity brings the water from a well in Apache Cañon. Gravity is also employed at Los Cerillos, where there is a well on the bank of the San Marcos Arroyo, and at Wallace, where there is a well on the bank of Santa Fé Creek. At Santa Fé a wind-mill is used, a well furnishing the supply.

RIO GRANDE DIVISION.

From Wallace, N. Mex., to El Paso, Tex.—From Rincon to Silver City, also Magdalena, Lake Valley and San Pedro Branches.

At Bernalillo there is a well 12 feet deep; at Albuquerque, one 12 feet deep; at Los Lunas, one 15 feet deep; at Sabinal one 15 feet deep; at Alamillo, one 13 feet deep; at Socorro, one 16 feet deep; all with steam and wind-mill. At San Antonio, one 15 feet deep; at San Marcial one 15 feet deep; at Lava, one 342 feet deep, with steam power. At Engle there is a spring several miles distant from the railroad. From this spring the water is forced by steam power into a reservoir located on the divide between the spring and the railroad. From this reservoir the water passes by gravity into the tank at the station.

At Rincon there is a well 14 feet deep; at Randall, a well 14 feet deep; at Las Cruces a well 18 feet deep; at Canertillo, a well 9 feet deep; and at El Paso, a well 24 feet deep, steam being the power at each station.

At Hatch there is a well 19 feet deep, with steam power.

At Florida gravity brings the water from a spring 27,000 feet distant from the tank.

At Deming there is a well 67 feet deep, the power being steam.

At Crawford there is a well 41 feet deep, fitted with a wind-mill.

At Siver City the supply is obtained from the Silver City Water Company.

On the Magdalena Branch there is a gravity line 5 miles long at Water Cañon, the source of supply being a spring, while at Magdalena steam power is used, the water being obtained from a well 28 feet deep.

At Osceola, on the Lake Valley Branch, there is a well 136 feet deep, and there is both steam power and a wind-mill. At stations where there is both steam and wind power the steam is only used when the wind fails to supply.

At Engle the water is raised 310 feet into the reservoir, which, as above said, is on the divide and about 2 miles from the spring and about the same distance from the tank.

Lava, Engle, and Upham are stations on the Jornado del Muerto, and at each station an effort was made to secure an artesian supply but without success. At the Engle well salt water was struck.

Upon the New Mexico and Arizona Railroad, extending from Benson, Ariz., on the Southern Pacific Railroad to Nogales on the boundary between the United States and Mexico, water is obtained at the following stations, viz: Benson, Contention, Brookline, Elgin, Crittenden, Calabusas, and Nogales, and in each instance the source of supply is a well and the power steam.

On the Senora Railway, extending from a connection with the New Mexico and Arizona Railroad to Guaymas on the coast, there are the following water stations, viz: Nogales, Agua Zarca, Imuris, Magdalena, Llano, Caibo, Pesqueira, Hermosillo, Torres, Artiz, and Guaymas. At each of these stations, with the exception of Imuris, the source of supply is a well and the power steam. At Imuris water is obtained by gravity from the river Casita.

The Senora Railway lies wholly within Mexico.

Partial list of elevations above sea-level.

	Feet.
City, Kans	2,268
r, Kans	2,479
tou, Kans	2,769
by, Kans	2,931
City, Kans	2,979
c, Kans	3,139
ıado, Kans	3,275
, Kans	3,307
y, Kans	3,448
Line Wichita County, Kans	3,470
ins, Tex	2,576
er, Tex	2,608
dian, Tex	2,347
Miami, Tex	2,751
Codman, Tex	2,892
Paten, Tex	3,345
Panhandle City, Tex	3.458
Cañon City, Colo	5,321
Pueblo, Colo	4,656
Colorado Springs, Colo	5,990
Palmer Lake (Divide), Colo	7,231
Denver, Colo	5,188
Walter Cañon, N. Mex	6,008
Magdalena, N. Mex	6,557
Kelly, N. Mex	7,149

ese elevations are on top of rail at station.

Table 328.—Wells on the Atchinson

(In Kansas, Colorado

WATER

Stations.	Laboratory number.	Date.	Organic matter.	Silica.	Alumina and iron	Carbonate of lime.	Carbonate of magnesia.	Carbonate of sodium.	Carbonate of potassium.	Sulphate of sodium.	Sulphate of potassium.
Topeka Shops	C. 55	May 2, 1884	.875	1.166	.641	11.782	1.490	.680	...	5.015	...
Grand Hole, S. Pedro C. Co.	C. 76	June 10, 1884	1.408	2.507	642	5.945	1.100	28.909	3.920	.....	2.960
Opato	C. 93	July 17, 1884	trace.	.519	trace.	17.136	1.880	.....	..	10.425	1.569
Alton	C. 94	do	1.728	1.167	.778	12.636	5.023	4.983	....	5.023	.656
Peabody (tank)	C. 104	Sept. 24, 1884	trace.	2.924	1.464	30.324	...	.....	...	6.638	.857
Pueblo (railroad tank)	C. 106	Aug. 9, 1884	do	1.213	trace.	14.804	.....	.....	....	9.416	3.024
Pueblo (city reservoir)	C. 107	.....	do	.431	.297	34.521	816	.328	.428	.216	.
Hillsboro	C. 180	June 25, 1885	.220	.580	trace.	41.047	.....	.....	....	8.309	2.150
Nickerson	C. 181	Nov. 12, 1884	trace.	510	..do	.959	3.310	.....	....	4.076	1.762
Raymond	C. 182	.....	1.297 volatile.	.777	282	3.812	2.333	.028	....	6.482	.960
Dodge City	C. 183	Nov. 20, 1884	trace.	3.031	.948	9.455	8.496	.....	.....	3.366	2.193
Spearsville	C. 184	do	do	2.686	trace	7.225	1.580	716	.302	.....	...
Ellenwood	C. 188	Nov 24, 1884	do	.980	.200	7.980	2.009	3.254	....	2.112	1.794
Great Bend	C. 189	Nov 22, 1884	do	464	464	6.500	2.233	...	....	13.094	2.441
Peabody	C. 194	Nov 30, 1884	do	2.328	1 169	31.929	...	...	....	16.473	3.569
Iron Springs	C. 197	Feb. 5, 1885	do	.968	021a	18.060	12.921	2.020	....	28.918	6.625
Kinsley	C. 198	Dec 4 1884	..do	841	.730	15.904	.....	23.564	....	.....	5.480
Larned	C. 199	....do ..	110	020	.087	10.640	...	...	....	9.202	1.874
Benson	C. 204	Dec. 20, 1884	trace.	.777	519	6.731	3.360	...	...	.	.....
Lawrence	C. 205	Dec 22, 1884	do	1.753	445	36.298	7 440	...	...	.....	.
Lava	C 228	Jan 20, 1885	.778	7 402	1 546	40.220	.....	...	....	38.622	9.429
Iron Spring (new spring)	C. 237	Jan. 24, 1885	trace.	.134	3.294	28.212	...	...	..	30.320	
Iron Spring (railroad tank)	C 238	do ...	do	.952	.600a	17.840	1.622	.....	.....	35.428	
Kansas River at Topeka	C 242	Jan 28, 1885	.716	1.016	980	14.409	1.625	...	....	4.177	
Kansas River at Lawrence	C. 243	do	802	1 149	.340	15.080	000	...	.....	4.720	
A T Well Lawrence	C 244	Feb 12, 1885	1 010	.868	1.449	32.827	1.551	...	...	7.016	
Silver City (railroad tank)	C. 255	Mar 4, 1885	trace.	2.202	1 720	43.546	14.324	...	...	29.794	
Deming (railroad well)	C. 256	Mar. 3, 1885					....	...	...	.....	.....
Nickerson	C. 267	Mar 7, 1885	.046	138	.102	15.620	4.198	...	.....	30.247	
Iron Spring (new spring)	C. 264	Mar 9 1885	trace.	126	3.031	26.620	...	...	.....	28.748	
Hudson, hot spring	C. 270	Mar. 19, 1885	do	1.552	502	4.448	2.624	...	.....	13.547	
Nickerson	C 271	Mar 23, 1885	do	808	.141	10.729	1.131	...	.....	3.229	
Gypsum Mills 6 miles northeast of Wallace.	C. 284	Apr. 6, 1885	do	2.040	1.436a	60.472	.....	...	..	213.534	
Maxwell	C 285	do	do	.384	1.157	17.106	11.337	...	.....	15.254	
Florida	C. 306	Apr. 15, 1885		.....	.....	...	....	...	.....	.....	....
Rincon	C. 307	Apr. 30, 1885	1.788	1.560	.519	14.721	3.695	...	.....	22.410	
Water Cañon	C. 308	do	.....	.....	.....	.....	.....	...	...	.....	.....
Osceola Well	C. 309	do	...	.	...	..	....	...	..	.....	...
New well, Topeka	C. 320	May 19, 1885	1.107	1 100	.882	11 930	3.632	...	.....	2.613	
Kansas River at new well, Topeka	C. 321	do	1.164	1.450	.901	11.956	4.094	...	..	2.090	
Topeka Water Works.	C. 330	June 11, 1885	291	732	.583	10.204	1.878	...	..	1.583	1.307
Upland	C 337	June 15, 1885	trace.	1 258	406a	8.001	3.449	9.751	.732	75.283	....
Carpenter's Smelter near Silver City	C 341	July 2, 1885	do	585	.344	15.450	5.848	...	.....	2.580	5.265
Kiowa, No. 1	C 350	Aug. 3, 1885	772	1 289	.516	10.883	5.158	9.109	...	8.820	
Kiowa, No. 2	C 351	do	trace.	.778	.315	7 193	5.442	11.659	..	2.120	
Las Vegas Well, Wood Preserving Works.	C 347	July 31 1885	do	289	trace.	13.507	2.186	2.546	.821	4.875	.....
San Pedro C. and C. Co.	C. 381	Sept. 21, 1885	5.627	1.922	3.844	22.948	30.195	...	....	103.685	
Dorsey Spring, 2 miles E	C. 385	Oct. 10, 1885	.188	776	104	8.166	1.800	...	....	3.123	
Silver City (new well)	C. 300	Oct. 31, 1885	trace.	.293	1.465a	19.730	3.732	.117	.....	6.532	
Kiowa (new well)	C. 391	do	...	974	.395	1.270a	12.522	.....	...	.....	7.702
Dodge City	C 395	Nov 21, 1885	trace.	2.336	577a	14.975	5.377	...	.	17 106	
Iron Spring, section house well.	C 396	Nov. 27, 1885	.727	570	.422a	2 641	2 503	47.652		.....	5.860
Medicine Lodge	C 409	Jan 7, 1885	811	1.167	1 783a	25.079	.....	.....	..	11.530	
Spring Creek (Medicine Lodge)	C 418	Jun. 23, 1886	trace.	291	.291a	0.320	1 056			9.389	
Elm Creek (Medicine Lodge)	C 414	do	do	.306	306a	11 611	1.880			5.472	
Peabody (new well of water works)	C. 452	May 20, 1886	do	581	873	13.082	3.237			12.113	
Argentine (pump house)	C 425	Feb. 5, 1886	1 749	1 142	.776	20.022	...			2.219	
Argentine (white house)	C. 424	....do	.....	1.551	2 385	.387	22.683	1.584		2.949	

[1] Trace of iron.

Topeka and Santa Fé Railway.
[New Mexico.]
ANALYSES.

Sulphate of magnesia.	Soluble carbonates sulphates chlorides of soda and potassium.	Chloride of sodium.	Sulphate of lime.	Carbonate of iron.	Totals.	Remarks.
.....	.....	7.463	.....	.....	29.921	
.....	.....	3.284	.....	.....	50.678	Not poisonous, but supposed to be. Red sediment is iron and organic matter.
7.739	.....	1.652	.....	.....	40.882	
.....	.....	1.830	.....	.....	33.824	
[illegible]	.....	3.097	3.259	.....	70.406	Poor. Large per c. sulphate of magnesia.
9.083	.....	5.032	2.403	.....	44.965	
.....	.....	1.619	.....	.....	7.656	Extra good.
[illegible]	.....	3.579	20.180	.....	97.074	Poor. Large per c. sulphate of magnesia.
.....	.....	3.939	4.842	.....	29.424	
.....	.....	6.413	.....	.....	28.304	On account of organic matter unhealthy for drinking.
.....	.....	4.720	10.549	.....	41.758	
.....	.....	1.489	.....	.....	13.998	Extra good.
.....	.....	2.982	.....	.....	21.981	A good water for comparison.
2.083	.....	3.598	.....	.....	30.876	
[illegible]	.....	3.942	1.431	.....	81.313	Poor. Large per c. sulphate of magnesia.
4.520	.....	.....	.....	2.500	77.756	Poor. Large per cent. of hard salts.
[illegible]	.....	12.846	16.127	.....	97.890	Poor. Large per c. sulphate of magnesia.
[illegible]	.....	1.631	.087	.....	29.156	
.....	20.449	.....	.....	.....	31.842	
.....	33.003	.....	.....	.....	81.937	Combined sulphuric acid. 10.356 grains.
[illegible]	.....	7.820	62.420	.....	205.460	Over 70 per cent. insoluble matter. Purification necessary.
[illegible]	.....	2.375	12.609	.....	102.084	Very poor.
[illegible]	.....	2.780	.....	2.680	76.392	Poor.
.820	.....	7.143	.....	.....	29.886	
[illegible]	.....	7.905	.....	.....	32.661	
[illegible]	.....	20.126	.....	.....	70.954	Will corrode brass fittings.
7.105	.....	15.699	.....	.....	114.480	Poor. Large per cent. of hard salts.
.....	.....	.....	.....	.....	16.329	Extra good.
.....	.....	20.920	.....	.....	77.271	This water must have a strong tendency to foam.
[illegible]	.....	2.316	11.240	.....	95.484	Poor. Large per cent. of sulphate of lime and magnesia.
.....	.....	2.286	.....	.....	24.959	Note large per centage of silica.
3.812	.....	8.261	.....	.....	28.171	
[illegible]	.....	20.676	22.665	.....	389.021	On account of large per cent. of Epsom salts, injurious to health, if used too freely.
5.039	.....	13.163	.....	.....	63.440	
.....	.....	.....	.....	.....	19.040	
.417	.....	14.364	.....	.....	59.464	Per c. of scale-producing material small on account of large per c. chloride and sulphate of soda. This water will attack brass and corrode fittings of that material.
.....	.....	.....	.....	.....	13.024	
.....	.....	.....	.....	.....	18.079	
[illegible]	.....	5.757	.....	.....	26.821	
.277	.....	5.763	.....	.....	27.704	
1.094	.....	5.145	.....	.....	23.417	
.....	.....	20.420	.....	.....	119.250	Poor. Will corrode brass fittings.
[illegible]	.....	4.300	.....	.....	34.387	
.....	.....	15.025	.....	.....	51.579	
.....	.....	3.874	.....	.....	31.381	
.....	.....	1.450	.....	.....	25.674	
.....	.....	16.470	.....	.....	274.691	Poor. Unhealthy for drinking purposes. Will corrode brass fittings.
[illegible]	.....	1.281	.....	.....	18.607	Good.
.....	.....	1.633	.....	.....	23.442	Good both for drinking and boiler purposes.
[illegible]	.....	7.795	.916	.....	45.853	Poor water on account of large quantity of sulphates. Will form hard scale.
1.742	.....	5.792	.....	.....	49.905	
.....	.....	23.418	.....	.....	83.792	Poor. Will corrode brass fittings.
[illegible]	.....	9.612	.....	.....	75.887	Poor. Large per c. sulphate of magnesia.
.....	.....	2.677	.....	.....	23.910	Good
.....	.....	2.419	.....	.....	21.994	Good.
.....	.....	2.435	.....	.....	32.321	Fair.
[illegible]	.....	1.603	.....	.....	29.742	
[illegible]	.....	2.556	.....	.....	36.837	

The *terms good, fair, and poor* indicate the value for boiler purposes.

STATEMENT OF GEORGE H. WEST, OF GREELEY, COLO., IN RELATION TO SOUTHWEST KANSAS.

We beg to submit the following information, covering those counties in Kansas south of the third standard parallel and west of the ninety-eighth meridian, embracing an area of 16,520,000 acres, of which fully 15,000,000 acres are suitable for agricultural purposes, relying for its best results upon irrigation.

At least 90 per cent. of this land is underlaid by subterranean flows or reservoirs of water, available from wells by means of mechanical power. The application of an economical method of raising this water would produce more immediate and general benefits than any other system, making from 60 to 75 per cent. of the entire area at once reclaimable by private enterprise.

Along the Cimarron River and its tributaries are 350,000 acres of first bottom lands, with abundance of water within 20 feet of the surface; while at least 500,000 acres in the Arkansas Valley will afford an exhaustless supply of water for ordinary irrigating purposes at 10 feet. The valleys of the Beaver, White Woman, Pawnee, Walnut, and their tributaries will afford 1,000,000 more acres of land, with an ample water supply from 15 to 30 feet. Outside of the valleys sheet water is found, from 30 feet to 100 feet, with an average depth of about 60 feet; excepting limited areas, including portions of nearly every county west of the ninety-ninth meridian. Embracing nearly all of Haskell County and a narow strip west through the counties of Grant and Stanton and east through Gray, Ford, Kiowa, and Pratt, extends what is known as the deep-water belt, or high divide. Another such area extends west through the counties of Garfield, Finney, Kearney, and Hamilton, along the fourth standard parallel. In these belts water lies at depths generally exceeding 100 feet. Outside these narrow belts the larger portion of the entire area is underlaid by a water supply, available to a mechanical method of raising it. The water is almost universally found running through gravel beds with a uniform current towards the east.

Neither coal or wood is found in the territory embraced in this report, and prices are governed by the length of haul and competition between lines of railroad. At Garden City the best Cañon City coal sells at the scales for $6.75 per ton, Trinidad coal $5.90, and Cañon City pea coal $4.65 per ton. No slack is sold, and we are unable to get the price of same to include in this report. Garden City is not a competing point, and the above are about the maximum rates on fuel along any line of road; while at competing points good fuel for steaming purposes can be bought much cheaper. The western half of the State has meager railroad facilities, but development through pumping or other system of irrigation would be followed by the extension of present lines through that section into the great coal deposits of Colorado and New Mexico, southwest of us.

No pumping system or irrigation has been tried, and the surface streams are totally inadequate to furnish an extensive water supply for a system of canals. The Arkansas River is the only stream that can be utilized in that manner, and the present demand upon it renders farming more hazardous than will justify further development in that direction without the application of a storage reservoir system, or in tapping the water-bearing strata with underground canals—taking advantage of the universal trend eastward. Such a system will be necessary to reclaim the high divides mentioned in this report, and will call for reservoirs of enormous capacity, as those lands, being uniformly unbroken, storage basins must be made at great distances from the areas to be watered.

The underground water supply will rapidly increase instead of diminish, as the water used will largely be absorbed by the soil, and percolation from above be added to the present sources. The water lost by evaporation will be replenished by the rain that will be enabled to soak into the soil, instead of wasting upon the impenetrable sod of our prairies. Most of Kansas has demonstrated that breaking the sod and continued cultivation of the soil will eventually result in the complete saturation of the dry soil, that almost invariably exists from the sod to the sheet water. The almost entire absence of clay beds and other impenetrable substrata will permit of the complete saturation of the soil down to the present water levels, making a storage reservoir of incalculable magnitude, proportionately increased by each additional demand upon it, and capillary attraction, now almost entirely absent, will soon be established.

By determining at once the practicability of mechanical means of raising water from our wells, these results can be accomplished by private enterprise in time to benefit the classes who most need aid and encouragement, and who are utterably unable to wait upon the action of the Government in devising and executing a more elaborate system of storage and canals. A pumping system will permit of individual *enterprise* and general adoption at once. Any system dependent upon the construction of expensive canals, reservoirs, subdrainage, or other methods involves unavoid-

e delay of governmental action, or in inducing capital to come to our relief. To nonstrate that a pumping system can be practically and economically applied will atly reduce the area of arid lands to be reclaimed, and afford a proportionate in-ase of the available water for that purpose.

STATEMENT OF SECRETARY M. MOHLER, STATE BOARD OF AGRICULTURE.

'hat portion of the State of Kansas west of the one hundredth meridian, as well some portions east of it, may be classed as semi-arid, and would be vastly im-ved by irrigation.
'he topography of the country also is such as to admit of irrigation on an exten-e scale.
'he difficulty, however, in the way is, the country is destitute of water. There are streams in that section of any consequence, and the only possible means of get-g a supply of water is either from the clouds by gathering the storm-water as it s or from the interior of the earth by artesian wells.
n my judgment irrigation by means of storm-water gathered into reservoirs is im-cticable except on a small scale. The chief, and I think the only, hope of irriga-n in that country is by means of artesian wells. Such is the opinion also of the tlers there.
'he underground water supply of the west is mainly obtained in two formations, Tertiary grit and the Dakota sandstones, which in some localities are so situated to give artesian water of good quality from comparatively small depths. Other ter but much mineralized is obtainable at greater depths.
'here is a series of irrigation canals in the Arkansas Valley, and it is possible that flood water of that river could be stored to irrigate larger areas. It is believed that the Cimarron and the Republican Rivers would supply water for irrigation large areas of extreme northwest and southwest.
'he crops of the western half of the State are substantially the same as east, only that ghum and rice corn do better than maize. Tree planting has begun and the State established a forestry station in Trego County, but too recently to give results

n the judgment of many parties I have met with it would be a good thing for the vernment and that country to solve the problem as to the practicability of irrigat-by artesian water by sinking wells in different localities. If it were once demon-sted with reasonable certainty that artesian water could be had, private capital uld be invested in developing the artesian water resources of that section.
'his idea, it seems to me, is of sufficient importance to merit attention.

[*Papers inclosed by Mr. Mohler.*]

TEMENT OF ROBERT HAY, OF JUNCTION CITY, ON NORTHWEST KANSAS, ITS TOPOGRAPHY, CLIMATE, AND RESOURCES.

[Prepared for the State Board of Agriculture.]

A State whose boundaries are so little irregular as those of Kansas could have its rthwest quarter or other similar portion marked off with definite lines if area only uired to be noted. The northern line of the portion under consideration would in s case be the Nebraska line, which is the fortieth parallel of latitude, and the south e would be the parallel of 38½ degrees. The western boundary is of course the lorado State line, or the one hundred and second meridian, and its eastern bound-y would be a meridian line whose longitude is 98° 20′ west of Greenwich. This stern line passes through the counties of Jewell, Mitchell, Lincoln, Ellsworth, and ce, while the southern boundary is nearly coincident with the line of the Santa branch roads from Lyons and Great Bend, or the Missouri Pacific line to Colorado, rough the counties of Rice, Barton, Rush, Ness, Lane, Scott, Wichita, and Greeley e area so defined has slightly over 20,000 square miles.
If, however, geographical features be taken into account, and not merely area, her boundaries might be used for a district that might properly be called northwest ansas. One convenient area might so be named which should contain all the region rth of the Smoky Hill River from the Colorado line to its confluence with the Re blican, near Fort Riley, in Davis County. This region would be curtailed in its uthern extent as compared with the previously defined area, but would make up increased easterly extension. Another district well marked topographically uld be the region between the Smoky Hill and Republican Rivers. This district, ile having considerable southeastern extension, includes parts of Colorado and

Nebraska. A better area for topographic description would be the drainage area of the Republican and Smoky, but this would include larger areas beyond the limits of the State, while its southern line would be singularly near the parallel of 38° 30′.

In this paper it will not be possible to give detailed treatment of even the smallest of the areas defined above, yet in dealing with the larger features, both topographic and geologic, the larger areas will have some notice.

The entire region here considered belongs to that part of our country known topographically as The Plains, or The Great Plains, but it has within it all the varieties of surface just mentioned, and the valleys of its water-courses are conspicuous features.

The fact least noticeable by ordinary observers, yet the one on which all other topographical facts are dependent in northwest Kansas, is that there is a general increase of elevation of the country westward. Of course, the least thoughtful traveler or settler is sure of this as soon as he has observed that all the larger streams of the region have an easterly course. It is also to be observed when the attention is directed to the subject when traveling on the comparatively level country—the high prairie—above the river valleys of the district. In this situation it will always be noticed that the western horizon is higher than the eastern. It is also to be observed when looking across the greater valleys that the northern plateau is higher than the southern one; *i. e.*, that there is an increase of elevation northward as well as westward. The former, however, is not so marked as the latter.

The direction of the streams indicates the elevation. The elevation is the cause of the direction of the streams. Examining a map of the region from the Mississippi to the Rocky Mountains, we find that between the Platte and the Arkansas rivers are a number of others streams, whose sources do not reach the mountains. The principal are the Smoky Hill and the Republican, whose highest gathering-grounds are in eastern Colorado, separated from the mountains by the Platte Valley. These two streams are seen to diverge, the one to the north the other southerly, and, entering Kansas, pass into the region we are discussing. As these streams diverge it is seen that others originate, of considerable length, but tributary to them at last, and occupying the region between them, as these lie between the Platte and Arkansas. There is a repetition on a small scale in the sources and courses of the Saline and Solomon, of the conditions under which the sources and courses of the Smoky and Republican were formed. Looking further east, another repetition of the same forms is seen in the Neosho and Marais des Cygnes, between the Arkansas and the Kaw, continued into the Missouri. This repetition of drainage-forms points to continuity of similar forces through long periods of time and persistence of the same conditions through wide areas.

The rivers, then, of northwestern Kansas are rivers of the plains—they are not mountain streams—and hence lack mountain snows and mountain rains as sources of their waters. Besides this difference in their water supply they have a very important difference in the form of their beds. The mountain stream is more rugged, steeper, and narrower as its nears its source. The river of the plain has a shallower, broader depression the higher it gets, and besides having less water its bed becomes scarcely noticeable at all as a valley. The valleys of the Saline, the Solomon, the Prairie Dog, the Sappa, and the Beaver become in Thomas, Sherman, Cheyenne, and Rawlins counties little more than depressions in a great rolling plain. The valleys of the Smoky and the Republican are the same a little farther west in Colorado.

Another characteristic of these river valleys is that at some distance down their courses, where they have decided depth and running water, they are more abrupt—in some places rugged—on their southern slopes than on their northern, and the tributaries on their south sides—right bank—are shorter than those from the north. This is of course referable as to its cause to the fact before mentioned of the increase of elevation northward.

This leads us to observe that the valleys themselves—all in the region—are the result of one cause—erosion. They have been cut out by the action of the streams now running through them, aided by the frosts and winds, and all other weathering agencies of ages past. Further, the differences in the character of a valley in different parts of its course are due to the differences in the material, the cutting away of which forms the valley, and which is the substance of the earth in different parts of the great plains. Of these differences more will appear further on.

A fact in the structure of the valleys that is noticeable by the least observant is the prevalence of *bottom land* in the lower parts and its gradual restriction in area and diminution in depth as we ascend towards the sources of the streams. This bottom land is usually level, with a gentle slope laterally—*i. e.*, upwards from the river, but with a marked exception in many places near the stream; that is, it is *there* higher than a little farther back, and this is manifestly due to the manner of *its deposit.* The whole material of the bottom land is what has been held in *mechanical suspension* in the water of the stream when in flood—sand, gravel, mud—

and has been deposited by the retiring waters, the finest material held longest in suspension being deposited in the gentle ridge near the stream. There is another evidence of this seen in the places where the recent workings of the stream have left the bottom in the form of overhanging precipices whose vertical sides show horizontal markings of sand, mud, or other alluvia alternated with black bands of vegetable soil, showing that at those stages of its existence there was freedom from flood for a sufficient number of years to allow the grasses and other vegetation to grow and decay and leave the carbonaceous material—humas—similar to that making the present surface of the bottom. These level bottoms are not usually the lowest bottoms of the river. They are no longer the flood plains, but are permanent as to their height, wasting away by present action of the stream as to their area. The flood plains of to-day are lower, usually more irregular, and becoming higher with each year's flood deposit. They are formed by the material from above, the high prairie as well as the older bottom, by the deposit of each year's flood. These present flood plains may be called the true first bottom. The level bottom occupying a higher position is the second bottom formed as first bottom when the stream was at a different level, and there is often a third bottom back from the stream 15 or 20 feet higher than the second bottom, and showing a similar condition of things in a period still further back. These phenomena—of the three series of bottom lands—may be observed in the narrow valleys of Big Timber in Cheyenne County, and of Beaver in Rawlins County, the Beaver of Scott and Wichita counties, valleys farther east of the Sappa, the Prairie Dog, the Solomon, the Saline, the Republican, and the Smoky. It is noticeable that the second bottom of one part of the valley becomes the third of a region lower down.

Of the streams themselves, *i. e.*, the main ones, we notice, in connection with the above facts, that they are at present occupied only in cutting away and redistributing the material of these bottom lands which they formerly deposited. In very few places in all northwest Kansas is any stream engaged in wearing away bed-rock. The South Solomon in eastern Osborne County is doing it a little; the Prairie Dog shows a little of the rock-bed near mill-dams, and this is true of the Saline and other streams.

In all the region there are no lakes. A few old river-beds, occasionally connected at flood-times with the present streams, are the haunts of fish or wild fowl, but there is no sheet of water anywhere wider than the present streams. A few of these old river-beds have encircled a piece of higher bottom that by courtesy is called an island, as at Long Island, in Phillips County, and such areas have timber. All the rivers east of the ninety-ninth meridian have timber. The Solomon has a little into Rooks and Norton Counties and the Prairie Dog has a few trees nearly to the one hundred and first meridian, and the Big Timber Creek has some in Cheyenne County; Beaver creek, in Rawlins; the Sappa, in Decatur; and also the Southern Beaver, in Scott County. But this region is essentially a prairie country. The valley of the Republican, from Jewell County to Fort Riley, and the Smoky, from Ellsworth to the same place, have abundance of timber. The trees natural to the country are oak, ash, elm, cottonwood, box-elder, walnut, locust, and hackberry; the ash, cottonwood, box-elder, and locust going farthest west. The red cedar is found as far west.

Taking the most extensive definition of our district, a strip from 15 to 20 miles in width across the eastern end of northwest Kansas from Washington to Rice County might be called comparatively a rough district, the great valleys being bounded by precipitous bluffs of hard limestone or ferruginous sandstone and the smaller ones being rugged ravines. Another strip, like the former, widening southerly from Jewell and Smith Counties across Mitchell, Osborne, Russell, Ellis, and Rush, being much smoother in the slopes of the hills. Again, a strip across Phillips, Norton, Graham, Sheridan, and Trego into Scott might be called rough, and the most western counties have a decidedly smooth contour. But these descriptions are only comparative, and parts of these districts would illustrate the opposite terms.

The general increase of elevation westward is due mainly to newer geological formations being added as we proceed in that direction. We shall see further on how all the topographical features are influenced by this, but the increment itself is mostly so gradual that its relation to the geology is not seen by the casual observer except in one instance, where the added series of formations make a conspicuous step on the prairie. This is where the limestone of the Fort Benton rocks comes first into view as we go west. In the valley of the Smoky, in Ellsworth and Russell counties, in Lincoln back from the Saline, in Cloud and Mitchell on the Solomon, these are seen capping the bluffs away back to the high prairie—a distant ledge and step higher than the underlying sandstones, and showing promontories and ridges with table tops scarcely less marked than those of the massive limestones of the lower courses of the Republican and Smoky Hill Rivers. This is a prominent feature of the topography for scores of miles.

There is a very interesting feature in the topography of the most western part of northwest Kansas, particulary in Sherman, Wallace, Logan, Greeley, Wichita, and

Scott Counties. It is the existence of depressions not connected with other valleys, basins having no outlet, separated from the general drainage of the country. Some of these seem to be in a line, and suggest an old river valley filled up with alluvial dams.

The main facts of the topography are—

(1) Gradual increment of elevation westward.

(2) Similar, but less marked, increment northward.

(3) The entire region forms part of the "Great Plains."

(4) None of the streams have their origin in the mountains.

(5) The streams all belong to one system, lying between the valleys of the Arkansas and the Platte, which are mountain streams.

(6) The valleys of the streams are all the results of erosion, having been cut out of the body of the "plains" by the streams and the other agents called "weathering."

(7) The character of the underlying rock and distance from highest part of the "plains" have resulted in two smooth and two comparatively rough districts, with mounds and bluffs—all hills of erosion.

(8) The upper parts of the river courses are without permanent water.

(9) The lower parts of the river valleys have more or less timber.

(10) The difference of elevation from a river valley to adjacent high prairie is not over 300 or 400 feet anywhere. In the west the valleys are mere depressions.

(11) There are basins in the western part not connected with the system of river drainage.

The source of most soils is the actual degradation of the geological deposits of past years by the action of rain and moisture, heat and frost, running stream and stirring wind. Some rocks, even the harder ones, have by these agencies been broken up in fragments and dust on the spot where they have lain for ages. Seeds of plants buried in this débris have rooted and grown, and by their chemical force and mechanical action have aided in still further breaking up the rock, and then their own decay has added substance to the soil thus formed, and it has gradually increased in thickness. A soil so formed is said to be sedentary. It is on the spot where as a soil it first began to be. Running water, and sometimes the wind, will carry off soils so formed, and also the rocky débris before it becomes soil, and redeposit it on the flood plains of rivers or on sand-banks and shores of the sea, and then plants taking possession convert them into soils as before. Such soils are said to be transported. Other designations are used for particular kinds, but all fall under these two main heads. Northwestern Kansas has soils of both kinds. The bottom-lands—first, second, or third—of creek or river valley are all transported soils. The great bulk of the high prairie and the sloping uplands have sedentary soil. The transported soils are of mixed ingredients; the dust of limestone, the grains from sandstone or granite, the mud from dissolved shales are all mixed in the composition of the river bottoms, and the most finely comminuted matter is in the best physical condition for furnishing plant-food. The sedentary soils are, on the other hand, composed mainly of the ingredients of a single bed of rock.

This is largely true of the principal soil of northwestern Kansas. The smoothly rolling high prairie, with its short buffalo-grass, has scarcely any depth of black soil or humus, such as is looked upon as the standard of value in soils, and which is often characteristic of bottom-lands. But underneath the sod of the prairie is the tertiary marl before described, which, though a rock in technical geological phrase, is a lake silt, composed of limy materials, sand, and clay. Turn it up with the subsoil plow, bring it from the excavation of a cellar, or from a well 100 feet deep, and in it plants will grow, and grow well. The rolling prairie of Cheyenne, Sherman, Wallace, Greeley, and the rest of the remote western counties have this subsoil as an everlasting resource. West of the one hundredth meridian this is the principal soil of the region. The valleys of the rivers are comparatively narrow, and bottom-land is not so plentiful. Coming east, the valleys widen, and besides there being more bottom-land, there are wider areas of slope where the substance of the sedentary soils is formed from older formations in all the soils of the Upper Smoky, the Walnut, the Saline, and the two Solomons. Still on the high prairie to the east of the limits above suggested is the sedentary soil of tertiary marl, and still traces of it on the highest lands farther east than middle Kansas.

But in these eastern parts—Smith, Osborne, Russell, Rush, Mitchell, Cloud, Ottawa, Saline, Ellsworth, and Rice counties—if bottom-land does not actually preponderate in area, yet transported soils occupy quite the half of the counties, as the smaller valleys are numerous and the river valleys broad and grand. Valleys are settled first. Sheltered from winds, they attract the pioneer; they give response to the touch of the plow. Their cultural features soon set off their natural advantages, and, the population increasing, all other advantages also increase.

On some of these slopes there are soils that are thinner, and as far as arrangement of material is concerned not in the best condition for plant-food. On these slopes the *grasses are thinner* and coarser. Some of them are on the exposures of shales. Where

these are clayey shales they are at first intractable to the plow, and are in wet weather the most adhesive of muds. They are locally called adobe or gumbo soils, and are found on the slopes of Russell, Osborne, Smith, and other counties where the blue shale of the Niobrara has outcrop. Yet these soils, after being once broken, are not infertile nor continuously intractable, but do not seem to have much power to resist drought. The area of these soils is not large.

Another class of soils of the less valuable kind are those that are gravelly. They have their source in the disintegration of the Tertiary conglomeration. They occur in unexpected places. Occasional mounds in the valleys and slopes of higher prairie are made of gravel that support but a scanty herbage, and indicate the former presence of the older Tertiary formation when its actual presence is no longer realized. Some of the higher mounds of grit have this bare, gravelly soil, but the entire area so covered is not great. The mortar-beds of the grit supply a sedentary soil, which gives a moderate hold to blue-stem and other grasses, and will probably supply a hold for forest trees.

The geology, the topography, the soils of northwestern Kansas are as favorable to the pursuits of man as can be desired. The climate needs some remark. Most of the settlers' trials come from the climate. Can it be modified to suit him better, or can he adapt his ways and his work to its peculiarities?

Climate may be considered under three heads: Temperature, precipitation, winds. We will notice each separately.

The *Temperature* of the Northwest may be fairly described as continental. That is, it has a wide range from summer to winter. The observations made in the region are too few to give much reliable material. It may, however, be said that while there are many days in winter that are below zero, yet it is not continuously so even in January. The severity of the winter is frequently broken by milder days. In summer the temperature rarely goes above 100° Fahr., but it is for some time in the nineties. The mean annual temperature is probably about 53° Fahr., but the position of isotherms it is not possible to state with exactness. Eight stations on the Union Pacific, from Brookville to Ogalallah, give a mean average for 1887 of 56°. Observations from the northern counties, and for more years, would probably reduce this. One of these stations gave 113° for the maximum and −15° as the minimum for the year. The lowest winter temperature given is −20°. It may be said that the highest temperature of the summer is not unbearable on the high prairie, and that the maximum given above is not duplicated anywhere in the region.

Precipitation.—This term includes rain-fall, snow-fall, and dew. In the early days of settlement there was a very little dew in northwestern Kansas; there is now much of it, especially in the spring months. The quantity of dew is not measureable except by a statement of the number of days on which it occurs. Further on we shall notice the probable significance of the increase of dew. Rain and snow are classed together under the term rain-fall, 10 inches of the latter being about equivalent to 1 of the former. Whatever the quality of soil or skill of the farmer, it is necessary that moisture shall be within reach of growing crops. If there is no rain-fall there must be irrigation, as in Egypt, or the land will be a desert. Again, the rain-fall must not only be sufficient in quantity, but it must come at the right time. The rain-fall of Kansas generally is greatest in the four growing months—April, May, June, and July—more than half the year's precipitation taking place in those months. The quantity falling is less, however, in western than eastern Kansas. Rain records have not been kept for any length of time in this region with any regularity, but seven years at Fort Wallace, in the extreme west, before any settlement of that or the neighboring counties (1875–1881), shows an average annual rain-fall of very slightly under 19 inches.

Five stations in Saline, Ellsworth, and Russell Counties give an average in 1887 of 25 inches. It would appear that the annual rain-fall is not too small to support vegetation or make prosperous the operations of the farmer, for good crops have been raised in the counties of Norton, Decatur, Rawlins, Cheyenne, Sherman, and others of the extremely westerly counties, as well as farther east, when it can not be said that there was exceptionally large rain-fall. But there is a defect in the rain-fall that seems to be climatic, and which, if it be moderated in the future, will only be so very slowly. There is in many western counties a spell of dry weather of two to four weeks in duration in July. This results often in damage to the corn crop. Wheat may have been harvested in fair quantity before this, and green crops, turnips, millet, sorghum, will do well from rains in August. If this fact be recognized, and corn of rapid maturity be planted very early or very late, this damaging time may possibly be defied.

Good farming and persistent breaking of prairie, planting of trees, may gradually improve the hot season, but the present generation can scarcely hope to benefit by it; but by going around the difficulty and putting to best use "the early and latter rains" they may not suffer so much as by simply farming on methods that were good in the rainy East or South.

Winds.—The prevalent winds of the region are north and south, south predominating largely. On the high plains of the more western parts there are, however, more variations to east and west than in eastern Kansas. The winds blow most of the time. There are few quiet days. The breezes make bearable the heats of summer. There are, however, two winds in western Kansas that are unpleasant and damaging or dangerous. Fortunately they are never long continued. The first is the blizzard of winter, rarely felt before Christmas, never after the end of March. It is unusual to have more than one or two in the season, and they do not last more than forty-eight hours. They are the mere fringes of the snow-storms which in the States and Territories farther north are so terrible. The other wind which is never welcome is the hot wind of summer, coming mostly from the south. It is this wind that is usually held more responsible for damaged crops than the lack of rain in July. But the two facts coincide often, and so give the maximum of damage. It is after one or two weeks of hot sun that the hot wind blows. It lasts one, two, or three days, and sometimes more. Corn-fields are literally burned up; those whose cultivation is the poorest suffering first and most, so that the poor settler whose single team is not strong, and has therefore not done the best work, and who may be depending on a single crop, sees his season's work wasted. The remarks made above about the choice of crops to raise apply here as well as in view of rain-fall. There has long been an opinion that the hot winds came from the far south and southwestern Territories. Settlers in western Kansas and those who have traveled much on the plains are of the opinion now that many of them are of local origin. Two facts may be mentioned that sustain this view: One is that sometimes the winds come straight from the north or west and is encountered suddenly, and its origin can be seen in the intense radiation of heat from burnt prairie, or otherwise bare earth or thinly-covered with vegetation; secondly, the failure of crops from this cause is not universal, but in streaks and patches. Counties as far removed from one another as Smith and Sherman and Scott this last season have had districts where all corn was destroyed and others where there has been a good yield. Still there are hot winds that come on gradually and last long enough to show that they are of distant origin and widespread influence. It is fully believed that the local hot winds will be modified and ultimately terminate by the persistent cultivation of the soil, the breaking up of the prairie, the planting of trees. Rain-fall may not be increased, but humidity will be more distributed through the season and the intense reflection of heat diminished.

STATEMENT OF O. ST. JOHN ON THE PHYSICAL CONDITION OF SOUTHWEST KANSAS.

[Forwarded by the State Board of Agriculture.]

The region especially referred to comprises the counties lying south of the Arkansas River and West of Medicine Lodge River, viz: Morton, Stevens, Seward, Meade, Clark, Comanche, the western portion of Barbour, Kiowa, and those portions of the counties of Ford, Finney, and Hamilton lying south of the Arkansas, including the disorganized counties of Gray, Arapahoe, Sequoyah, Grant, Kearney, and Stanton, embracing an area of about 10,000 square miles, or 6,400,000 acres, wholly comprised in the Arkansas drainage system.

The Arkansas, which forms the northern boundary of the district, has a general course a little south of east from the point where it enters the State, in Hamilton County, some 70 miles north of the southwest corner, for a distance of 132 miles, to the eastern border of Ford County. Here it is deflected to a northeasterly course, forming the great bend, which embraces the almost as extensive, fertile, and populous region comprised in the counties of Stafford, Pratt, Kingman, Harper, Sumner, and portions of Sedgwick, Reno, Rice, Barton, Pawnee, and Edwards, lying to the east of the present district.

The Arkansas, along this part of its course, receives very few affluents on either bank, and none of these are of considerable size, save Bear Creek, which rises to the west of the State line and drains an important fertile area within the limits of Hamilton county. Many of these affluents, before reaching the river, sink in the loose soil that composes its broad bottom plain, and Bear Creek on entering the belt of sand hills that borders the south side of the valley, ends in a deep basin or sink, whence its waters percolate by underground channels to the main stream. Few of these streams afford permanent supply of water, and during the greater part of the year, except here and there the presence of water-holes, their beds are marked by a ribbon of sand. The Mulberry, in Ford County, is the next largest stream on the south side of the river. None of these streams to-day have any timber, except a few scattering trees along the courses of some of the north-side affluents in Hamilton County. Indeed, along the banks of the Arkansas only a slender belt of cottonwoods is seen in the same quarter.

The greater part of the district is watered by the Cimarron, which enters the State *near the south*west corner in Morton County. Flowing northeasterly a distance of

about 60 miles to the southwest portion oi Finney County (or the southeast part of Grant County), it swerves to the southeast, crossing Seward County diagonally, and enters Indian Territory near the middle of Meade County, whence it flows easterly some 30 miles, just south of the State line, to the middle of Clark County. At the latter point the stream bends to the north, flows through the southeast portion of Clark, and finally leaves the State in the southwest part of Comanche County. The great bend to the west embraces nearly the whole of Stevens County, a gently undulating plateau traversed by no considerable drainage channels. Indeed, all the principal affluents of the Cimarron within the limits of the State gain the stream upon its north bank. In the west the North Fork and its tributaries drain the southern and northern portions of Hamilton and Morton counties, gaining the main stream in the southeast part of Finney (near the southeast corner of the disorganized county of Grant. In the middle section Crooked Creek drains a large area, including Meade and the southeastern and southwestern portions of Finney and Ford Counties. In the eastern section Six-Mile, Big Sand, Bear, Day, Bluff, and Cavalry Creeks and their numerous affluents drain Clark and the western portion of Comanche, to the east of which the drainage flows to the Medicine Lodge and South Fork of the Arkansas.

The Cimarron rises far to the west in the region of the eastern plateau extension of the Raton Hills, in northeastern New Mexico, where indeed its volume is much greater than it is along that part of its course within the bounds of Kansas. It is here a small brook only a few yards wide, and in places during a portion of the year its waters are lost in the sandy bed. In early summer its low banks are sometimes overflowed. The above-mentioned affluents mostly afford pools the year round, and like the larger stream they are subject to overflow from the heavy local rains that occur during the summer months. In the past these pools were the resort of the herds that pastured the adjacent plains, and the Cimarron Valley was, until recently, entirely occupied by stock ranches and thousands of cattle. The recent immigration of agricultural communities has changed all that, and to-day the valleys and plains are dotted with every description of domicile from the "dug-out" and sod-house to plank and stone dwellings, and the uncultivated prairie is everywhere covered with smaller herds and flocks, which are furnished abundance of pure water from wells.

As was surmised from the results of the few experimental tests made prior to 1884, abundant supply of good water may be obtained in wells almost everywhere in the region here referred to. The subterranean sources that supply the wells are encountered at variable depths, ranging from a few feet to above 300 feet. The water stratum apparently forms a shallow basin, the center of which lies in the southern portion of Finney County, where at present are found the deepest wells. The almost absolute assurance of reaching water by digging or boring certainly greatly lessens the hardships of the necessary expense in seeking water by this means. The pleasant custom often followed by some of the settlers of locating their dwellings on adjacent corners of quarter-section tracts, forming snug little hamlets, makes it possible to reduce the cost of a deep well to the individual by making one excavation supply the needs of four families. The reported failures to reach water are very few, and over far the larger part of the area the average depth will probably fall short of 100 feet. In no instance does the water in these wells rise to the surface, and generally it stands only a few feet above the point of inflow.

The water of the Cimarron is slightly brackish along the lower portion of its course in the State, as is also that of Salt Fork, but this in no respect injures it for stock purposes. Beyoud the limits of the State the former stream expands into wide shallow flats, which receive annual deposits of salt from the evaporation of the overflows, which it is said have accumnulated in places to the depth of a couple of feet, and where the natural product may be shoveled up by wagon-loads. All the tributary streams afford good water, some derived from springs, which, though not of very frequent occurrence, are met with at various points. Spring Creek, a west-side tributary of Crooked Creek, in the southwest portion of Meade County, is supplied with a clear flowing current from numerous springs along its upper course. At Evansville, in the southeast corner of Comanche County, a copious spring issues from the tertiary gravels on the borders of a pretty little valley tributary to Indian Creek, at the Comanche Cattle Pool's Ranch. And elsewhere in the district springs appear in the valley sides or are recovered by means of shallow excavations.

The shallow depressions characteristic of the gently undulating uplands that so widely prevail in this southwest region very generally form receptacles for the accumulation of the surface drainage of more or less considerable areas, which for a part of the year at least are converted into shallow ponds, and the remainder of the season appear as vegas of dark green herbage. Even the larger of these basins, like Deep Basin and Wild Horse Lake, in the southeast and northwest portions of Finney and Meade Counties, which when filled to the brim by the rains of the early season are very pretty little bodies of water, are known to become dry during the

fall and winter months. There are other pools and sinks, like that in the course of Bear Creek, which is said to be a deep funnel-shaped basin formed in the loose soil of the sand hills, affording a perennial supply of water. In the valleys of the Cimarron and some of its tributaries small alkali basins are met with, but these comprise areas of inconsiderable extent, and are indicated by the usual efflorescence emanating from the soil composing their margins and beds. Some of these pools are very pretty features in the valley landscape, like those in the north tributary valley of the North Fork of the Cimarron above Ulysses, which are frequented by a variety of water fowls in the spring and autumn months.

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Far the greater part of the district comprises a gently undulating prairie, with a moderate southeasterly declivity in the direction of the drainage courses which furrow the surface. While the altitude ranges between 1,500 and 3,300 feet, culminating in the upland summit between the Cimarron and the Arkansas on the western border of the State, the relative elevation of the uplands above the stream levels rarely exceeds 200 feet. The Arkansas occupies a broad shallow valley comprising an immense area of level bottom-land, usually presenting two low benches, the narrower of which forms the present flood-plain along the margin of the stream, and which affords valuable meadows. The stream itself presents a very uniform appearance—a broad sandy bed threaded by shallow channels, and bearing grassy islets, and confined within low earth-banks. In places the bars are composed of gravel; elsewhere treacherous quicksands prevail. The melting of the snow in the mountains about the sources of the Arkansas fills its banks brimful of turbid, sediment-laden water in early summer, when the volume of the stream is at its greatest. The bordering uplands present some variety of grassy declivity, generally long, gentle slopes, retreating in the vicinity of tributary valleys, where the bottom-lands present magnificent expanses of level plain, elsewhere approaching the stream in low bluff declivities broken by rocky ledges. To the west the bluffs become somewhat more abrupt, showing one or more limestone terraces.

While the foregoing features are met with along the north side, quite different appearances obtain on the south side of the valley throughout the course in the district. This is due to the presence of sand, which, in the course of comparatively recent times, has accumulated to such extent as to form a nearly uninterrupted belt of sand hills of variable width, 1 to 10 miles, along the south border of the valley, and presenting marked contrast to the soil-mantled slopes of the opposite side. The surface of the sand-hills belt exhibits the uneven contour of downs, and that their origin is attributable to the action of winds as the transporting agent, seems highly probable. Although their surface is to-day clothed with a more or less dense growth of herbage, a sort of rank, brown-topped bunch-grass being the characteristic prevalent variety, in places still exist patches of loose, bare sand, where the tireless action of the winds may be witnessed under conditions identical with those encountered along the sea-board. The surface rises into irregular hillocks, with intervening and often quite deep basin-like depressions, having no connection with the infrequent drainage channels that traverse the belt, and south of Garden City they culminate in elevations at least 100 feet above the Arkansas. From these elevated points the contour of the sand hills may be best observed, presenting an irregular, rolling belt, strongly contrasting to the gentler undulating, smooth, buffalo-grass-carpeted plains to the south, as also the north-side uplands. Many of the basin-like depressions in the sand hills are based upon a firm, brown soil in no way distinguishable from that prevailing in the adjacent prairie surface, and like it also in being covered by a mat of buffalo-grass. The occurrence of these remnants furnish additional evidence bearing on the inference respecting the comparatively modern formations of the sand hills, and their probable encroachment, through the agency of the winds upon the earlier formed prairie surfaces that once swept down in gentle slopes from the upland levels into the valley.

The sand hills, though unfit for agriculture, are by no means barren wastes. They are more or less densely clothed with a variety of grasses which afford fair pasturage, and abundance of water doubtless may be obtained by means of wells. The belt varies in width from 3 or 4 miles at the State line to about 10 miles at a point south of Lakin, to the east of which it as gradually diminishes in width until in the vicinity of the Mulberry it forms but a narrow belt. East of the Mulberry it again increases in magnitude, a wide arm drifting from the bend in the Arkansas between Dodge City and Kinsley, in an easterly direction across the northern tier of townships in Kiowa County. A gently undulating plain stretching east and west from Wendal in Edwards County, intervenes between the south range of sand hills and the narrower belt bordering the Arkansas, between which latter and the river occurs a wide and exceedingly fertile valley plain upon which are located many fine

farms. Water is obtained at moderate depths in wells, as is also the case in the sand-hills belts in this quarter.

South of the sand hills stretches the great upland plain that extends over to the Cimarron. Its surface features present a more or less gently undulating contour, marked by broad, low elevations and intervening wide levels. A remarkable uniformity in the character of the soil obtains over the greater part of the area, consisting of a slight brown, fine loam, possessing the constituents of fertility, and tractable under cultivation. Bordered on the south by the Cimarron, along which the upland breaks in more or less abrupt declivities, it is traversed by many valley depressions occupied by tributary streams, and which exhibit a variety of appearances. In the northwestern section a considerable area is tributary to Bear Creek, which opens out into a wide shallow valley, bordered by comparatively moderate grassy slopes; farther west the valley narrows, and the stream is excavated in the Cretaceous sandstones that often outcrop in the low bluff ledges. The stream itself is deeply eroded into the soil, and for a portion of the year its course is marked by a dry, sandy bed.

South of Bear Creek the drainage of North Fork of the Cimarron has fashioned similar valleys, separated by low, sometimes gravelly, ridges, and showing at intervals low bluffs along their courses. The lower course of the North Fork is hemmed by steeper upland slopes, rising in benches, and the bottom-land is somewhat sandy. The stream flows between steep, grassy banks, and even its bed is often grassed over like the meadow swales along its margin. South of the Ulysses the upland on the south rises about 100 feet above the valley, the south-side brink commanding a fine view of the Cimarron Valley. This upland flat extends far to the southwest between the parallel courses of the main and lesser streams, averaging about 5 miles wide, and generally occupied by recently commenced farm improvements.

Water, which is not abundant the year round in the streams, is reached in wells at various depths in the region here referred to. In the upland between the Cimarron and the North Fork, wells reach depths of from 50 to 170 feet, as in the vicinity of Taloga and Frisco, and at Richfield 50 feet. To the north of the latter place in the uplands south of Bear Creek, the depth varies from 100 to 170 feet; the latter depth was reached at Johnson City. To the north, in the valley of Bear Creek, the depth diminishes to 60 feet, as also to the east in the vicinity of Shockyville and Surprise, where water is obtained at 35 to 75 feet. But in the uplands north of the latter valley the depth reaches 170 feet.

The Cimarron, throughout its course within the limits of the State, occupies a well-defined valley, and is bordered by low meadow intervales, sandy and gravelly benches, and grassy upland slopes, which rarely reveal the nature of the strata in which the valley is excavated. Along the upper portion of its course, in Stevens and Morton Counties, the border slopes attain elevations of 75 to 125 feet. The higher acclivities occur along the north side of the valley, and present, as seen from above, a range of quite abrupt bluffs running out into high rocky points dominating the valley, as at Point of Rocks, a few miles east of the State line. The valley gradually deepens to the east, and below the confluence of the North Fork the border slopes attain an elevation upwards of 200 feet, exhibiting interesting effects of weather action on the soft variegated strata composing the bluffs. The lower course of the river within the State flows through a wider, shallower valley plain, which, in Clark County, is occupied by belts of low sand-downs, and hemmed by gentle acclivities, broken here and there by low rocky bluffs, like the gypsum bluffs on the borders of Clark and Comanche Counties.

The considerable area embraced in the great bend and lying between the Cimarron and the State line on the south, comprises an undulating upland, the surface features of which are very similar to those met with to the north. This area includes Stevens and the southeastern and southwestern half of Morton and Seward counties respectively. The surface drainage is performed by shallow draws, which, on the eastern and more abrupt border, debouched into deeply-eroded ravines, which score the edge of the upland on that side. This plain gradually rises from the edge of the Cimarron Valley southward, culminating on the southern border of the State, where it is loaded with heavy accumulations of sand, forming characteristic low, irregular, hills. This sand-hills belt is apparently similar in origin, as it is also in position, to that traversing the northern townships of Kiowa County on the Arkansas, previously mentioned, or an offshoot from the sand-hills at the west end of the great bend of the Cimarron. The plain is hemmed on the north by sand-hills which form a nearly uninterrupted belt, 1 to 3 or 4 miles wide, following the south side of the Cimarron Valley, presenting the same characteristic features as elsewhere ascribed to the sand-belts, their rolling conformation of surface, old prairie basis, and mantle of herbage with which they are clothed. But in the latter section, the drifting of the sand has extended the area of the sandy loam soil, which forms a wide, outlying belt flanking the sand-hills, and encroaching on the fine loam lands characteristic of the original prairie surface, as met with in the central portion of the area. This

sandy loam, characterized by strips of blue-stem and bunch-grass, interspersed with patches of buffalo-grass, is fertile, and capable of growing excellent crops, as the past season's experience affords ample proof. Twenty to thirty bushels of sod-corn per acre were produced on this soil, besides other cereal crops and vegetables, and the various sorts of native and fruit trees thrive as well in these situations as upon the ordinary prairie soil. Water collects in shallow pools, affording temporary supply for stock, and excellent and abundant supply is obtained in wells at depths of 75 to 130 feet. At Hugoton, near the center of this area, water was reached at 80 feet; to the east and west the depth of wells increases.

Isolated and considerable areas of sand also occur on the east side of the Cimarron, along the edge of the uplands bordering the valley. In the latter quarter similar modifications in the original character of the upland soil, due to the encroachment of sand upon the adjacent prairie surface, are met with, as have been already noted, on the south side of the valley. These sand-hill areas continue eastward past the confluence of Crooked Creek, to Big Sand Creek, in Clark County, beyond which they occur in low hillocks occupying the widened valley plain.

A large part of the upland plain lying to the northeast of the Cimarron, embracing the northeast portion of Seward, the southern portion of Finney (or the old county of Arapahoe), and nearly the whole of Meade County, belongs to Crooked Creek drainage. The western portion of this area presents a gently undulating surface, with a light-brown, fine loam soil, and clothed with a luxuriant growth of buffalo-grass. The sources of Crooked Creek furrow the surface with shallow draws, with grassy beds, and pools of water. Within Meade County the valley gradually deepens, with gradual border slopes, and occasional groves above the north bend. The Arkansas-Cimarron watershed is here crowded far to the north—the summit lying less than 12 miles south of the former stream, and presenting a broad, low, undulating upland, scarcely more conspicuous than that separating the Mulberry from the Arkansas, which, southwest of Dodge City, scarcely exceeds 175 feet above the latter stream. In the region of the great bend the valley forms a broad vale, from which the surface gradually rises into the general upland plains on the east and west, in the midst of which are situated the villages of Wilburn, Pearlette, and Fowler. The stream here shows reaches of water between low, grassy banks, and margined by meadow intervales. To the south the valley becomes deeper and the border slopes steeper, with occasional exposures of rock. Below Meade Center, in the vicinity of Odee, the borders become quite abrupt, rising 150 feet above the stream, and cut by deep ravines. Several pretty little spring-fed streams here descend the west slope, their valleys widening on approaching the main valley, with extensive meadows of blue-stem. Along the lower course of the stream its waters sink in the sands composing its bed.

In the high prairies of the southern part of Finney County, water is obtained in wells at depths ranging from 65 to 336 feet. The greatest depth of the water-bearing stratum is found at Santa Fé, about midway between the Arkansas and the Cimarron, the average depth of wells in the region being about 160 feet. To the east, in the slopes occupying the great bend of Crooked Creek, water is reached at depths of 30 to 50 feet.

East of Crooked Creek a similar undulating upland forms the dividing ridge between that stream and numerous smaller affluents flowing southeasterly to the Cimarron, and curving round to the northeast, it merges into the high prairie of the main watershed that extends eastward along the northern border of Clark and Comanche Counties. East of Meade Center the summit reaches an elevation of about 100 feet above Crooked Creek. To the east the surface descends in a succession of broad, low undulations, gradually becoming more and more broken as the watercourses deepen their channels. The sources of Big Sand, Bear, and Bluff Creeks, in the northwest portion of Clark County, score the upland with deep ravines, giving the declivities a rugged character strongly contrasting with the tamer topographical features prevalent to the west. However, the lower courses of these streams flow through broad valleys, separated by undulating low uplands based upon the gypsiferous red-beds, which impart to the warm loam soil its peculiar color. The aspect of that arm of the highlands separating the Big Sand and Bear Creek drainage from Bluff Creek is peculiarly broken, showing high, dome-like hills, mesas, and headlands, commanding a most instructive view of their deeply eroded banks, the lowlands of the Cimarron and the upland heights far to the south beyond the limits of the State. Except the more broken belt at the sources of the streams, and which afford good pasturage, and the sandy intervales bordering some of the streams, the region possesses fertile soil, and is well adapted to agriculture. In the lowlands the soil is a warm, reddish loam, while in the highlands a light-brown fine loam occurs, identical with that prevalent in the region to the west. In the latter quarter water is found in wells at depths of 75 to 125 feet east of Meade Center, and at Letitia, in Clark County, 109 feet; in the lowland section, wells vary from 20 to 75 feet in depth.

Bluff Creek, the easternmost important tributary of the Cimarron within the State,

drains an area of over 500 square miles, in Clark and Comanche Counties. The main stream, as also its principal affluents, Kiowa and Cavalry Creeks, rises in the great divide, the first few miles of its course being bordered by gentle upland slopes. As the stream deepens its bed in its southeasterly course through the northeast part of Clark County, it is confined between steep bluffs, and lower down in the vicinity of Lexington, the valleys widen, with long intervening slopes between the intervale and the upland heights. Below the confluence of Kiowa Creek, whose sources have similarly scored the southern flank of the divide, it presents a broad valley expanse, occupied by low, gently-undulating bench-lands, offering inviting agricultural locations, and finally merges with the more or less sandy plain bordering the Cimarron, in the southwest corner of Comanche County. The wide west-side slopes, after leaving the highlands, are composed of a reddish-brown soil, which also occurs in the low uplands between Bluff, Day, and Bear creeks. The east slopes are more sandy, and the summit traversing the central portion of Comanche County, and forming the watershed in which the Nescatunga, or Salt Fork, of the Arkansas rises, bears a belt of low grassy sand-hills lying between Coldwater and Nescatunga. Cavalry Creek is bordered by moderate upland slopes, which along the lower portion of the valley terminate above in a line of low bluffs which form the western rim of the broad shallow flats about the sources of Salt Fork. The ridge reaches an elevation of about 225 feet above Bluff Creek, and is an interesting geological feature, being based upon the gypsiferous red-beds, and crowned by a remnant of the lower Cretaceous.

The Salt Fork of the Arkansas, and its numerous affluents, perform the drainage of the central and eastern portion of Comanche County, and the southwest portion of Barber County. The main stream, which rises in the upland flats east of Cavalry Creek, flows easterly along the north border of the southern tier of full townships to near the east line of Comanche County, and thence southeasterly beyond the limits of the State. The upper course is merely a deeply-eroded draw, traversing the shallow, basin-like plain known as "Koller Flats;" but below Avilla a few miles, the stream is bordered by intervales and hemmed by bluffs, which gradually become higher, descending the stream to the eastward, and in the vicinity of Evansville the south side presents buttes and lines of precipitous bluffs, with a heavy coping of light-gray gypsum, resting upon red-beds. Several affluents gain the stream upon both banks, those to the south deeply scoring the north declivity of the highlands extending east from the Cimarron along the State line. The north-side upland is also drained by several tributaries which occupy pretty little valleys. The most important of the latter is Mule Creek, which drains the northeast portion of Comanche County and the western border of Barber County. Throughout the greater part of its course it occupies a well-defined valley, the sandy flats bordered by sloping benches that rise into the steeper declivities of the neighboring uplands 150 feet or more above the stream. Like the other tributaries, the stream is a clear, rapid, shallow current, its tortuous course lined with trees, indicating the rapid declivity of the stream-bed. The whole region above alluded to is clothed with a luxuriant growth of native herbage, the uplands occupied by the nutritious buffalo grass, and the valleys with blue-stem meadows, affording abundance of hay. The undulating uplands here present a greater variety of soils, due to the diversity in character of the subjacent geological formations from which they are derived. With the exception of the sandy intervales bordering the water-courses, and the arm of sand reaching eastward from Cavalry Creek valley, the general character of the soil is a warm, fine loam, in places gravelly, and generally fertile.

The uplands east of Mule Creek, in the western portion of Barber County, present a much more rolling surface. The drainge channels are deeply eroded into the peculiar red deposits prevalent in that quarter, and certain sections present quite broken and even rugged surface features. Yet, even here, the narrow summits of the ridges separating the streams often expand into undulating areas, affording favorable locations for farms, as is the case in the upland between the Cimarron drainage and that flowing north into the Medicine Lodge. The latter stream, a clear, rapid brook, winding between low banks over a sand and gravelly bed, here occupies a beautiful valley, hemmed on the south by precipitous red bluffs, capped by a heavy ledge of gypsum, which form the edge of the broken uplands which rise into heights 200 feet or more above the stream. The space between the foot of the bluffs and the stream is occupied by a sloping bench, from which the red escarpment rises to a height of about 150 feet above the valley. The slope on the north side more gradually rises into the great divide, and is unbroken by conspicuous bluff escarpments. Toward its sources, in the southern part of Kiowa County, the stream flows in a broad, shallow valley, from which the surface gently rises into the neighboring upland summits. Indeed, Kiowa County presents a remarkably uniform undulating surface, except the southern tier of townships, in which the south-flowing streams take their rise, the erosion of their beds having produced a more rolling surface contour.

STATEMENT OF MARTIN ALLEN, OF HAYS CITY, ON HOW TO INCREASE AND PRESERVE THE WATER SUPPLY.

Suppose the prospector to be where the surface is reasonably level, and the depth to the water level be 60 feet, and shale is found at one-half this distance. Abandon that prospect at once and try, say, 100 feet therefrom, and if the shale is here found at 46 feet deep, go another hundred feet in the same direction and he will have a reasonably sure thing of getting water at 60 feet and above the shale. With this system of prospecting and its various modifications, adapted as they may be to each particular case, good sweet water can very generally be obtained in central Kansas by digging or boring for it. In some places, however, there are high, smooth localities with the best of soil, where the water is very deep, and other places where the shale is more persistent, and still others where the natural water is not good. In all such cases there is one simple and efficient remedy, that of putting in one or more cisterns, as may be needed. These may be an excavation in the ground, walled on the sides (which may be either square or circular), and well cemented, being covered by an arch or other suitable device. They should be so located that the water can be led into them by a furrow or other device, when such cistern can be very readily filled each winter or spring from the melting snow led from a drift, that can always be depended upon for a supply as sure as the snow falls and the wind blows, by using a fence, a row or two of trees, corn or sorghum stalks, or even weeds, to stop the fullest fury of the winds and snow with it. In this way there need be no failure to obtain at reasonable cost an ample supply for household use of the best of water. If it be not clean or clear enough, a simple brick wall through the center of the cistern—filling it from one side and using from the other—will cure the difficulty. If the cistern is shallow, as it should be for ease in drawing water, and it becomes too warm for drinking, an occasional hundred pounds of ice dropped in during summer will cure this trouble.

In my first knowledge of central Kansas it had scarcely a furrow plowed in its surface, and the one rule most arbitrarily enforced was the annual burning off of the grass. Sometimes this was begun as early as July or August. This grass was very short, with none of the tall sorts, or any weeds. The earth itself was very hard and compact, much like a field used to corral a large herd of stock in a wet time. It turned water almost equal to a shingle roof. These were years of extreme floods, and practically without the "dews of heaven." Since, however, we have a few plowed fields as reservoirs to hold water, and have put an end to the wholesale burning of the grass; the vacant land is much heavier coated, and with a large increase in the tall sorts. Weeds also abound wherever they can get a foothold. These all tend to prevent the old-time flow of water into the streams and out of the country, as well as to prevent rapid evaporation. They often gather snow drifts on level land (when before it blew away); this melts and soaks into the ground.

The result of all these influences were without any perceptible increase in the annual rain-fall. Places that were bare only a few years ago are now well covered with herbage; the atmosphere is more moist, trees are now succeeding that could not a few years ago be coaxed from one year's end to another; cellars can now be dug with a spade, or plow and scraper, when a dozen years ago the pick would have been the only effectual tool, and the genial dews are no longer strangers to us.

Among the elements that may here be mentioned as valuable aids in the retention and preservation of water are, plowing the soil or breaking the crust so that water may the more readily penetrate it, which may be followed by subsoiling or trench plowing, so that a surplus of water at any time may the more readily sink down deeply, where it will be held in reserve for the time of need, and not be forced from necessity to pass rapidly over a hard and often sloping surface toward the sea.

Saving the natural growth of grass from being burned has from actual observation a most wonderful effect, not only in preventing the free passage of water following a rain-fall out into the neighboring streams, but to prevent evaporation as well. To understand these matters in their full force, the observer must, as I have done, both examine adjacent burned or unburned lands at time of and closely following a rapid rain-fall. And again, put a breaking-plow into both burned and unburned lands just at a time when it is getting too dry to break land with ease. * *

May not the plowing of a single furrow in the stubborn sod for a mile in length over the level plain be followed with taller grass, weeds, and even the taller sunflower along its line? When the snow comes a drift is found to the leeward of this line, and when it melts the water soaks into the ground; and thus is an additional supply, for the time being at least, preserved.

Again, let us, in working or making our public and private roads, do just the opposite of what the people are compelled to do where the surface of the whole country is *more level* and therefore moisture more abundant. Indiana and Illinois annually *spend large sums* of money to get rid of their surplus moisture along their high-

s; in other words, to cure their mud-holes by various devices of ditching, drain-
filling, and putting in bridges, culverts, etc. All these are among what are
wn as public improvements over vast areas of the Eastern and Middle States, but
ned quite unnecessary in Kansas, especially in the central and western parts, that
upposed to be suffering from the want of moisture.
w let us in making and working all our public and private roads, whether we
them or not, make dams wherever such roads cross over slight depressions.
e will be found very numerous—say from three to five for each mile. But for
ake of argument let us suppose that there are only two to each mile of road and a
on every section line: this calculation would give to the western two-thirds of
State the enormous number of 212,800 such dams. And suppose these on an
age to each cover one-fourth of an acre, and to be an average depth of 1 foot;
vast amount of water that can be retained by this simple method can readily be
ed out.

STATEMENT OF H. R. HILTON, OF TOPEKA, ON MOISTURE ECONOMY.

ie theory of general acceptance is that the loosening of the soil more freely ad-
the air, which gives up part of its moisture when brought in contact with the
er soil. This theory will be true while the soil is cooler than the atmosphere, but
n the atmosphere is cooler than the soil, which will generally be the case be-
en midnight and morning, than the soil must, on the same principle, give up
of its moisture to the atmosphere. In striking a balance the greater gain would
ably be with the soil, but the actual gain of the moisture obtained from this
ce will not account for the benefits that frequent loosening of the soil confers
n showers are infrequent and temperature high; and we must attribute the good
lts that follow, not to the moisture robbed from the atmosphere, but rather to
saved and economized in the earth.
ie location of Kansas, between the fortieth and thirty-seventh degrees of latitude,
ects it to high temperature in the midsummer months; and if an interval of two
ree weeks occur without rain—and this is to be expected in July and August—
the best methods that the intelligent farmer can devise are necessary to tide the
ving crops over these trying times. The injury that would result from the ex-
re of the corn crop—now one of our greatest staple products—to these intervals
ry, moisture-exhausting weather, can be very much modified, if not obviated, by
wing the capacity of the soil on the farm to receive and store water beneath the
ace, and how this water is drained away from the surface soil to various depths
he substrata and pumped back to the surface again to supply the wants of the
ving plants.
f the rain-fall over a large area of the country it is estimated that less than one-
finds its way back to the sea, more than one-half being evaporated back into the
osphere again. No tests have been made in Kansas to determine what percentage
ie rain-fall is drained off in our streams, but owing to the larger acreage of un-
ken primitive sod than of cultivated land, the surface drainage will naturally be
ter than in countries where the greater part of the soil not covered by native tim-
has been cultivated at some time in the past. Eastern Kansas, owing to larger
tive acreage cultivated, probably drains off less than half its rain-fall, while
tern Kansas drains more than half. The water drained from a deeply cultivated
will, however, be much less than the average of the country and the amount
orated from it much greater. Only in instances when the rain-fall is excessive
in a given time will there be much waste by surface drainage from a well-culti-
d field. What escapes is mainly by subdrainage. We may say, therefore, that
rain-fall drained out of a country is, so far as the growing crop is concerned, rain-
wasted or lost, and the rain-fall that is held in the soil and evaporated back into
air again is rain-fall utilized or saved.
ie water in the soil not drained into the streams is evaporated at the surface or
spired by the growing plants. By the law of capillary attraction water ascends
ugh the spaces between the fine particles of sand or clay, from the reservoirs be-
The finer the sand or particles of clay, the smaller will be the spaces between,
the higher water will rise through these small nature-made capillary tubes. In
porous or friable clays or coarse sand or gravel the height that water will rise by
llary attraction is limited. The quantity of water raised in a given time de-
ls on the capillary power of the soil. If fine and capable of raising water 20 to
et, the process will be slow. If capable of raising water 10 feet, it will be much
e rapid, the quantity being gradually reduced as the height is increased.
ie same law applies to the drainage of the water from the surface and storing it after
ll of rain. The surface soil to depth cultivated takes in the water rapidly until
saturated. If rain continues falling faster than the subsoil will absorb it, than
surplus must waste at the surface. The amount stored for future use is deter-
ed by the nature of the subsoil and capacity to absorb. If the capillary spaces

are small, drainage will be slow; if large or coarse, it will be rapid. The law that elevates the moisture to take the place of that evaporated at the surface also draws or sucks the water down from the surface to the water reservoirs, or water level below, after each rain. It follows the law of supply and demand, ascending or descending as the point of greatest deficiency is at the surface or at the water level.

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A stratum of gravel within 15 to 25 feet of the surface works an injury to the growing crops in a very dry season, unless it is constantly filled with water. This also will be true of solid rock, or anything that tends to break the capillary connection between the level to which the water drains and the surface.

Keeping in mind this law, let us take, for example, a corn-field in the month of June. The ground between the corn rows has recently been cultivated and the soil to depth cultivated is loose and finely pulverized. A thunder shower common to that month gives an inch of rain-fall. The ground to the depth cultivated rapidly absorbs the water until fully saturated. One-fourth to one-half of the additional rain that falls at that time will probably waste at the surface, because the compacted subsoil can not drink in the water as rapidly as the loosened surface soil. After the shower the subsoil, if not impervious clay, will gradually drain the water out of the surface soil, part of it to be drained off through springs into the streams and part of it to be held in reserve and returned again to the surface. The effect of the heavy thunder shower on the soil of many of our Kansas farms is to pack the soil. This packing establishes a capillary connection between the subsoil and surface, and permits the moisture to come to the surface, thus exposing it to the hot sun and air and rapid evaporation. To prevent this great waste the capillary connection with the surface must be broken by cultivation just as soon after the shower as the land is sufficiently drained of surface moisture as to be worked with a cultivator. The soil thus loosened and pulverized acts as a mulch, covering the compact soil underneath, in which the larger roots of the corn plant are lodged.

The point of evaporation is at the surface, where in July and August the mean temperature is fully as great as that of the air. The high temperature rapidly dries out the surface soil, and would rapidly exhaust what was stored in the substrata did we not take prompt measures to protect our reservoirs by cultivation. The moisture rises just as far as the soil is compacted, and finds its upper limits at the roots of the plants, where it is needed. The mulch of two or three inches of loose soil forms a cool covering to protect it from the evaporating heat at the surface. The moisture in the subsoil is thus saved and economized for future use.

I feel confident that the experience of many farmers will confirm the statement that on clean ground, where the suppression of weeds does not figure, the corn that has been cultivated as soon after every packing rain as practicable has given the best results.

As we study this law of capillary attraction and understand the important relation it bears to successful farming, we must be impressed with the importance of a better knowledge of the physical properties, not only of the surface soil we cultivate, but also of the substrata. The method of cultivation will depend on the nature of the surface and the subsoil.

The law of capillary attraction as applied to development of the corn-plant and the conservation of moisture can be summarized by a homely illustration.

The corn plant is the pump; the temperature is the pump-handle; the water stored in the subsoil the well; the capillary tubes the pipe connecting pump with well; cultivation of soil is the packing at joints of leaky pipe-stem to prevent waste. The pump-stroke is determined by the temperature—slow in May, a little faster in June, and a long, rapid stroke during high temperature in July and August. If a pump that is being worked hard fails to throw water by reason of shortage of water in the well, its mechanical parts are injured, so when the hot days of July are at the pump-handle and the moisture is not supplied at the plant's roots as rapidly as it is being transpired through its leaves. then injury is wrought to the plant. The curling leaf in the heat of the day tells us plainly that the pump-handle is working too vigorously—that the supply of water in the reservoir is not equal to the draughts upon it. The return of the corn plant to its normal condition in the cool of the night tells just as plainly that the water supply is equal to the demand. But the corn plant can not recuperate many times from such overdrafts and if relief does not come in shape of a timely shower or lower temperature, the plant shows sign of distress in the "firing" of its lowee rleaves and whitening of the tassel. In a time when the reservoir is low and temperature high the advantage must be with the smallest-sized pump on the varietyof corn that exhausts the water supply slowest.

The luxuriant growth of the corn plant and of every species of vegetation during the showery months of May and June is something to which we "point with pride" as evidencing a very rich soil, and yet this great fertility that in normal seasons *shows such* wonderful productiveness is a source of injury to the corn plant in dry *seasons like those of* 1887 and 1888 in western Kansas. The height of the plant, thick-

ness of stalk, and rich profusion of leaves require for sustenance an amount of moisture proportioned to the size of the plant. The ranker the growth of plant the greater its demands on the supply of water in the soil and the more quickly will the supply be exhansted.

If it is desirable, then, to economize moisture during our rainy and growing season, to carry our unmatured crops as far into the dry months as possible before ripening them, does not this suggest deeper plowing, thus increasing the capacity of the soil to receive and retain the rain that falls, and prevent the waste at surface? Except in very sandy soil, or in land where the subsoil is very porous, every field should be "subsoiled" at least once in ten years. Subsoiling is very necessary in prairie lands recently brought into cultivation. Our virgin prairies are "hide-bound" by the tramping for many years of great herds of Buffalo. Plowing 6 or 8 inches does not break through the hard upper crust and open the pores in the earth's skin. It requires subsoiling to aid it, and this should be as deep as plow and power can do it.

Subsoiling 12 to 15 inches will increase the rainfall of Kansas by saving nearly all that is precipitated over the land so plowed. Intelligent cultivation to conserve the moisture, as well as prepare and supply food to the plant, will greatly increase production.

Keeping constantly in mind the law of capillary attraction, it is easier for us to understand what an important part the buffalo played in producing an arid climate suited to their life and wants. The constant tramping of their feet year after year manufactured a clay roof over the soil of the greater portion of the plains. It was almost water-proof. The rain-fall, probably as great then as now, was rapidly carried into the streams and out of the country to the sea. What little found its way into the soil was soon evaporated because of the capillary connection with the surface afforded by the trampled soil. Only the buffalo grass, with its long, slender roots penetrating deep into the earth and capable of maintaining its existence on a limited supply of moisture, could survive in such a hard-packed soil. This buffalo-trodden, sun-baked soil, aided by the bleached color of the buffalo grass, reflected the sun's heat back into the atmosphere, producing an arid climate even in seasons when the rain-fall, if utilized, would have been sufficient for crop production. The pioneer settlers following close upon the retreating buffalo, or large cattle herd, had to dig their cellars with a pick. Fifteen years later a cellar could be dug out of the unbroken prairie on similar ground with a spade. The effect of the winter frost is to loosen the surface soil. With no buffalo or cattle at hand to trample it firm again and stop the threatened leaks the spring rains worked into the soil a little, softening the surface. Each succeeding winter's frost and summer's rains, when left to work out this problem in their own way, undisturbed by wild or domestic animals—for the pioneer settlers had but little live stock—changed the nature of the prairie sod by making it more mellow and receptive, taking into the soil more of the rain-fall than was possible when the prairies were under the régime of the buffalo.

A ranker growth of grass followed the mellowing of the surface and increase of moisture in the soil. The fire-guards of the settlers; the prairie-wagon trails, and the patches of breaking here and there, all combined to protect the grass against prairie fires and promote the preservation of the grasses. These in turn shaded the ground more from the sun and retarded the drainage of the water from the surface by holding it in check. Thus the ranker grass on unpastured and unbroken land aids in storing the rain-fall and in preserving it when stored, so that after ten or fifteen years cellars can be dug with spade, where formerly the pick was used. If the condition of the soil could be so much modified by simply "resting" the land from wild and domestic animals, how much more benefit must follow the breaking up of the prairie sod, which, after a few years' cultivation, opened the pores in the earth's skin and induced a more natural, healthy action of the system.

The blue-stem grass covers more than double the area of Kansas that it did thirty years ago. It has always followed in the wake of settlement, and rarely preceded it. It could not find a foothold in the hard, dried-out soil of the buffalo grass. As the ground gradually softened and increased its water absorbing and saving qualities the blue stem increased. We find it in advance of settlement only in the sand hills or sandy river bottoms that, owing to small per centage of clay, do not pack like the level prairie lands. Here the rain-fall was absorbed rapidly, and the substrata seem also to have wonderful capillary power in raising moisture from below. The blue stem selects the most moist spot on the prairie for a beginning—first a few spears, next season a little larger, many nuclei are started, and these grow and spread, smothering the short buffalo by its ranker growth, till the whole surface is covered.

It is noticeable that where the blue stem has taken possession of one-half of the ground, and is fenced off for pasture and stocked with cattle, that the buffalo grass more than holds its own against the encroachments of its stronger neighbor; but if a similar tract is kept as meadow and free from stock that the work of substitution goes on and the blue stem prevails. Buffalo grass thrives and spreads on a tramped

and compacted soil; blue stem requires the loosened and moistened soil for its best development.

The arid climate of the plains comes more from the tramping of many feet than from any other single cause. Entirely remove the herds and keep out the prairie fires and the climate of the plains will be modified. I do not pretend to say that the rain-fall will be materially increased or that it will be sufficient for all the agricultural products of that latitude, but the rain-fall utilized will be largely increased, the heat radiated from the surface will be less, the average mid-day temperature will not be so oppressive.

The natural drainage of the soil of Kansas, like that of all the trans-Missouri country, is superior to that east of it. The soil under deep cultivation will absorb a very large percentage of the rain that falls—at least four-fifths. The soil of central and western Kansas has a more perfect natural drainage than in eastern Kansas, excepting in some of its river bottoms. An average rain-fall in central Kansas of 25 inches will be equal to 30 inches in eastern Kansas, because of its better drainage and storing capacity and the better subsoil for raising water by capillary power, and we find the average production taken for ten years fully as great in central as in eastern Kansas.

Western Kansas averages less than 20 inches of rain-fall. This fully utilized may be sufficient for special crops requiring minimum supply of moisture; but whatever benefit, if any, that might result from deep cultivation with this rain-fall there is no doubt that central Kansas will be the beneficiary, for this cultivation and increased storage of the rain-fall on the frontier will temper the winds coming from the south and west to the country lying to the north and east.

I want to make one or two points a little clearer in regard to the water not getting up through shale. I am now talking only about the water that falls. If the water can not come up through the shale, it can not go down through it, and if it does go through it can come back again. Here is a body of gravel, say 20 feet below the surface. When it is full of water, the soil is moist. As quick as the rain falls it goes down very rapidly; but if that dries out in the warm summer and the soil is more or less dry all the way through, when you have rain it goes down very slowly; it would be good drainage until you get that all moistened and full of water again. When there is no moisture down below, the water will not drain down, and is then evaporated very rapidly. I forgot that point, and I want to call special attention to it; that when the soil is moist all the way down the soil drains naturally and rapidly; but when it is dry and there is gravel underneath you have got to have this full of water in order to suck it down.

STATEMENT OF ALFRED A. WOODWARD, SURGEON U. S. ARMY, OF FORT LEAVENWORTH.

That I believe practically the whole of what is generally known as the sage-brush country can be brought under agriculture by a system of wells reaching the deep water-bearing levels, and that, speaking generally, this would be less costly and more efficient than canals drawn from natural water-courses. But each large topographical section must present its own engineering problem.

I have no intelligent opinion to express as to the strictly sandy deserts. I believe, further, that the systematic cultivation of forests on the plains, and their preservation on the mountains, will materially aid in the distribution, if not in the actual increase of the annual rain-fall.

Attention is invited to the propriety of planting forests with the view of breaking the sweep of winds, especially from the south, whose course in the summer is so frequently followed by general desiccation. Such belts on a large scale, as suggested by Col. Charles F. Adams, jr., of Massachusetts, will probably materially modify the climate of Kansas and Nebraska in its relation to agriculture.

STATEMENT OF L. R. HARE, FIRST LIEUTENANT, SEVENTH CAVALRY, U. S. ARMY, FORT RILEY.

When I first went to Dakota in 1874 it was then considered impracticable to plant potatoes on high ground; experience since has shown the fallacy of such an assumption. The "Gumbo" grounds in the vicinity of the Black Hills produce as fine potatoes and vegetables allied to the potatoes as can be produced. Some of the lands in Arizona and New Mexico are especially adapted for producing onions and allied plants, but I know of none of these lands that would be at all useful unless water could be supplied.

I have not had sufficient experience in Kansas to justify a conclusive report, but I am satisfied that through the greater number of years a "dry spell" occurs which if it could be bridged over by artificial means would make a wonderful difference for the better in the result.

STATEMENT OF J. L. POWELL, SURGEON AND CAPTAIN, U. S. ARMY, OF FORT SUPPLY, IND. T.

It has been my privilege to traverse on horseback the greater portion of the arid belt located in the area of Texas, Indian Territory, Kansas, Colorado, Nebraska, Wyoming, Montana, and Dakota, and I dare say there are few persons who have been raised in the productive regions of the Atlantic or Pacific slopes, where all the conditions of rain-fall, temperature, etc., combine, under the operation of a regular cyclical law to give variety to the pursuits of man, who would not, at first sight, assume that every foot of territory east of the Rocky Mountains and situated in the area indicated would be utterly worthless for any purpose save that of grazing, and very much of it not even for that. Such were my impressions some sixteen years ago, upon the occasion of my first experience on the Western plains while serving as medical officer to various commands operating against hostile Indians. Since then I have had an opportunity of watching and noting what can be accomplished by courage and enterprise, even in a section so forbidding as that which it is proposed to consider, and the result has been to cause a material modification of my views, and to suggest to me a chain of possibilities for this Western desert, so to speak, which I think are neither visionary nor impracticable.

Wherever agricultural or horticultural pursuits have been attempted under the least favorable conditions the results have been more than gratifying, indeed surprising. Every measure of success, however, has had its concomitant of failure, which, I think, may be largely attributed to a wide-spread fallacy that prevails as regards an increasing rain-fall over the Western prairies. To my mind the data do not justify an affirmative conclusion on this point, and the results have been not only damaging but cruel.

To those who have fixed their homes in the valleys and near the banks of the small streams that here and there traverse the plains, the results have not been so unsatisfactory, and where they have been so situated as to make available for purposes of irrigation the water supply, which though exceedingly limited and circumscribed in extent, it has proved to be the only thing needful for the raising of every variety of farm and garden product. As long as the climatic conditions, chiefly as respects rain-fall, continue as they are farming and garden pursuits must be confined to the narrow acreage of the villages, while the broad and expansive mesas will continue to produce the tough buffalo grass without hope of reclamation, save by artificial agency, and just so long prove to be the rock upon which the hopes and spirits of many a hardy pioneer will be dashed in a vain endeavor to extract from their parched surface the means of a livelihood.

From what has been said it will be readily understood that the amount of land available as homes for the annually increasing tide of immigrants to the West, constitutes but an insignificant portion of the millions of acres embraced within the territory that was formerly termed the "Great American Desert."

When it is considered that but one condition is necessary to bring this whole region, alike valley and plain, into a uniform adaptability to all the pursuits in which a rural people engage, the question of means to the end is one which assumes the highest importance and merits the wisest and most serious consideration.

It is admitted that the soil possesses all the elements of fertility. How then shall be supplied the other essential for successful tillage? What method, in the absence of the requisite amount of rain-fall, which is the marked peculiarity of the region in point, and by which circumstance it is so distinctly differentiated from all others, can be thought of or suggested as a substitute for cloud precipitation? There is but one source from which it is possible to derive the needful moisture that must nourish and sustain the farmer's crop, until seed time and harvest have passed, and this is to be found on the lofty peaks of the Rocky Mountains where nature has established a perpetual reservoir in the great snow heaps that are there annually collected and dissolved away and then sweep on unimpeded and unutilized to the ocean.

By taking up a map of the United States and tracing a line from its most northern boundary to the Gulf of Mexico and about midway between the Mississippi Valley and the Rockies, one will be struck with the number of water-courses of various size that will cross it as they make their way eastward, following the tread of the great watershed that they would be supposed to drain. Like the waters, however, that make the Colorado and Columbia Rivers, they, too, come from the mountains and not from the plateaus, through which they flow, for the amount of precipitation that annually falls on the great plains east of the Rockies is too small and too infrequent to require a channel to take it to the sea. What there is of it is quickly absorbed by the arid soil on which it falls. It is a remarkable and striking fact, then, that while these same plains that we are now considering are so parched and barren, on account of an almost entire absence of rain-fall, comparatively speaking, there periodically flows across them a volume of water that can only be described as incalculable. The annual rise and fall, uniform and at stated periods, of the Yellowstone, the Missouri,

the Platte, the Arkansas, and other water-courses that have their sources in the great mountain chain that stretches north and south across the western portion of the United States, confirm this statement.

American enterprise, alert and ever on the lookout for a theater in which pecuniary recompenses will be the reward of energy properly applied, has already grasped the situation and at various points we hear of private or corporate measures being set on foot to utilize in the reclamation of the barren lands of the West the great waste of waters that annually runs to the sea.

Some three years or more ago, while on duty in the State of Colorado, I had an opportunity of becoming acquainted with a project that was inaugurated by a joint stock company for diverting a portion of the waters of the Arkansas River from its proper channel, for purposes of irrigation, by means of a canal, the exact dimensions of which I can not now recall. This canal, starting from a point well up to the foothills, that loom up towards the west, so as to give it sufficient elevation as it advances eastward to distribute its supply over the plateaus that skirt the valley of the river, has been the means of opening up and introducing to new pursuits a great portion of the immense acreage of that region that heretofore has been considered as little less than a barren waste.

I am informed that the project has been attended with signal success, and that now on the open prairie are to be seen thriving homesteads, dotting the landscape, and yielding to their owners, by the process of irrigation, for which they are charged a certain rental, an ample return for their labor and investment.

I know of and have heard of other similar instances, but on a smaller scale, illustrating the efficacy of irrigation in regenerating the barren lands of the West. Since commencing to formulate the thoughts that I here present, in connection with the subject under consideration, I have come across the following extract which I clip from a popular magazine. Speaking of irrigation in Idaho, the writer says.

"Lands that are irrigated always produce large crops regardless of the seasons or of rains or drought; but it is not alone in regions devoid of rain that irrigation is profitable. It is an absolute necessity in some places, but also a great help to agriculture everywhere. Thus what would seem a curse often turns out a blessing in disguse. Idaho, where irrigation is an absolute necessity, now offers the farmer an absolute advantage over ordinary land with the average rain-fall of the east. There is no seed, labor, or crop lost by dry or wet seasons. The farmer in Idaho, being obliged to resort to irrigation, is quite independent of the weather. He can make his crop early or late at will, and can have his land wet or dry, as suits his convenience, for plowing, cultivation, or harvesting. Under these circumstances crops are usually of superior quality, and therefore bring higher prices. The ditch companies are extending their operations in the vicinity of the Boise River with most gratifying results, so that now Idaho valleys can not be excelled by any region east of California for the production of fruit. The sage-brush lands are soon turned into fruit farms, and the amount of fruit produced annually far exceeds that on unirrigated lands. Yet in future the most profitable use to which the irrigated lands will be put will be the growing of hay for winter feeding of stock, and the millions of acres of southern Idaho now awaiting irrigation will bring great profit to their owners, as well as to the irrigating companies who propose to carry the water to fertilize the land, which is really of fine quality and lacks only the water to make a successful and profitable field for stock-raising."

Thus far what has been said has been chiefly to indicate the advantages that will follow upon the introduction of a general system of irrigation in the arid region of the West.

But there are certain conditions in connection with it, which, in view of a possible infringement upon private and vested rights already established by long tenure and recognized under law, may require to be conserved and guarded by such measures as can only be applied by Congressional enactment. Especially is this likely to be the case with reference to the great arid region east of the Rocky Mountains. May it not happen that by the diversion of the waters for irrigation, as in the manner indicated on the Arkansas, the time may come when those who live below the points where the irrigating canals tap the main streams may feel the damaging effect of this wholesale depletion? It is true this state of things is likely to be experienced only during what is termed the dry season when the rivers are low.

During the spring thaw the volume of water flowing away from the mountain-sides would be vastly more than enough to meet the requirements of a much denser population than is now settled in the West. It would be well, then, to inquire into the feasibility of devising a sytem of storage by which a portion at least of the water that now yearly runs to waste could be held at different points along its pathway to the sea, to be distributed for such purposes as it may be required as the summer season progresses.

I believe the suggestion is a perfectly practicable one, and that the end can be attained by a series of dams, the construction of which, though beyond the pecuniary

possibilities of private enterprise, would be a matter of small moment if fostered by national aid. By the method proposed it is not unreasonable to hope and expect that districts now far away from any living stream of considerable size may ultimately have the benefits now possessed by more favored localities. In the possibilities of a combined system of irrigation and water storage I believe is to be found the only hopeful and promising outlook for the barren lands of the West.

Granting now that the argument on the lines laid down is based on the logic of facts, there are certain theoretical questions, in connection with the subject, which before bringing this paper to a close it may be worth while to consider. It is accepted as true, that the primary source of all precipitation is the ocean, consequently the heavy rain-fall that takes place on the western coast of the United States is but a return of the aqueous vapor that has been taken up by the prevailing winds from the evaporating surface of the Pacific and conveyed over the land. But why should not this heavy precipitation occur this side the line of the Sierra Nevada and Rocky Mountains as well as beyond?

The answer is to be found in the known fact that temperature decreases with elevation, so that these wind and air currents in their endeavor to leap the mountain ranges are carried up to the snow line, and being further chilled by the cold sides of the mountain have all their moisture squeezed out of them, to be returned to the earth in the shape of snow or rain. But suppose these air currents, laden as they are with moisture, could escape these mountain barriers and be conveyed over the arid region that is giving us so much concern, is it not reasonable to infer that from time to time they would be taken by force of cyclonic aspiration and those variations in temperature that produce aerial circulation to the higher strata of the atmosphere where condensation would occur? The theory appears a plausible one at least, and the suggestion brings us back to a consideration of the effect that so large an evaporating surface as would be developed by the impounding plan that has been pointed out would be wrought on the present climatic conditions that prevail. It is not unreasonable, I think, to assume that it would be marked, and that we might justly hope and expect that a greater, more gentle and equable, precipitation would take place everywhere, while those violent electrical phenomena that are the accompaniments of an excessively dry atmosphere would grow much less frequent in their manifestations.

The foregoing thoughts, rather hastily prepared, are respectfully submitted. If they contain a single valuable suggestion in assisting the committee to a satisfactory solution of the problem before them I shall be glad, for I feel that to assist in promoting in the least degree the development, the grandeur, and the resources of our common country should be the pride of every American.

STATEMENT OF F. M. SHELTON, OF STATE AGRICULTURAL COLLEGE, MANHATTAN, KANS.

[Being those portions of a report forwarded by the college regents of an inquiry recently made by the professor of agriculture which relate to the advisability or otherwise of irrigation in western Kansas.]

For many years, but particularly within the last eight or ten, the question of the settlement and agricultural occupation of the western and drier portions of the State has engaged the earnest thought and effort not alone of those directly interested as owners and cultivators of these lands, but of scientists, publicists, and even moralists, whose interest in the theme is based on the broad ground of public good. The efforts at the settlement of western Kansas do not make a cheerful chapter in the history of the State. The scores of abandoned farms, with their ruined "dug-outs" and other small improvements seen in all these recently-settled western counties all speak of brave efforts ending in futility. It is noteworthy, however, that great and far-reaching as the disasters of the last three years have been to the plains farmer, there have been many exceptions to the rule of failure. Here and there in almost every community may be found cultivators who have been reasonably successful; farmers who have made steady if not rapid headway in freeing themselves from debt and improving their stock and home surroundings.

From the fact that the settlement of western Kansas has progressed with various interruptions for twenty or more years, it would seem that there must have accumulated, particularly with successful farmers of this region, many valuable facts the outgrowth of much experience, and that these facts, if brought to the attention of inexperienced settlers would certainly prove of great value to them. With this thought in mind I was instructed by the board of regents of the Kansas State Agricultural College to proceed to various points in western Kansas, there to meet farmers and others interested in the problems involved in this investigation, and ascertain from them, as far as possible, facts for use in this report.

During the month of October I visited Ellis, Trego, and Wallace Counties, on the

Union Pacific Railway, while a little later on the line of the Atchison, Topeka, and Santa Fé my inquiries were extended to Ford and Finney Counties. If my acquaintance with plains farming had been limited to the information picked up in the course of these few trips I should consider my qualifications for the work meager in the extreme. In justice to myself, I think that I may say without risk of egotism that an experience of sixteen years as a farmer and teacher of farming in central Kansas, and as a lecturer before farmers' gatherings, many of which were held in the region in question, to say nothing of a very extensive acquaintance, personal and by correspondence, with farmers of every section of the State, and the numerous excursions made during the past summer with the sole view of studying the condition and prospects of agriculture in western Kansas, have furnished large opportunities for the study of this subject.

The journey from the east to the west line of the State, and on to the crest of the Rocky Mountains, is steadily one of ascent, the rate of increase in elevation increasing enormously as we near the western limits of the State. Thus, at Kansas City, on the Missouri River, the altitude above sea level is 763 feet; at Manhattan, 118 miles west, it is 1,042 feet above sea level; at Ellis, 302 miles from the Missouri River it is 2,135 feet in altitude; while at Monotony, a station on the Union Pacific Railway a few miles distant from the Kansas-Colorado line, an altitude of 3,741 feet is attained. Coincident with this change in elevation, a gradual but none the less striking variation in scenery, climate, and the character of the soil and its productions is noticeable. The soil changes in color from deep black in the east to light brown or yellow in the west; the grasses become shorter and thinner on the ground, while timber trees are not only much less numerous, but are scrubby, stunted, and gnarled, and their growth is strictly limited to the immediate vicinity of water-courses. Several counties in the extreme west are reported to have no native forest trees of any kind. These are not mere seasonal, superficial, and temporary indications which the agriculturist may safely disregard; they are fundamental facts, due to differences in elevation or position in respect to the more elevated regions west, and to variations in climate. They have existed since long before historical times, and are certain not to be changed by the agency of man. The variation in rain-fall, the fact of chief importance to agriculture, as progress is made west, strikingly illustrates the general trend as well as the nature of the varying conditions above referred to. Thus, at Fort Leavenworth, the annual rain-fall is 38 inches; at Topeka, 32; Manhattan, 30; Salina, 29; Fort Hays, 22; Wa Keeney, 19; and Fort Wallace, 13 inches, omitting unimportant fractions in each case.

The plain inference from these facts seems to me to be that the agriculture of western Kansas, whether practiced with or without irrigation, must differ from that which experience has shown to be best for eastern Kansas. The grand mistake made so far in the attempt at the settlement of western Kansas, and the cause of nine-tenths of the failures and distress that have so repeatedly overtaken the people of that unfortunate section, has been the practical assumption by them that crops and a system of farming that have proved successful in a region having 32 inches of rainfall could accommodate themselves to a section which was watered with less than 20 inches of annual rains.

Western Kansas differs from the eastern portion of the State in well nigh all essential agricultural conditions. In elevation, character of soil, rain-fall, and natural products there is between two sides, or rather ends, of the State not merely a difference, but a radical and fundamental divergence. And these differences will be in the future essentially what they have been in the past. Of course, seasons will vary here as elsewhere. Occasionally, as in 1860, 1874, 1881, and 1887, the plain climate will be carried east to the Missouri River or beyond, and, again, not unfrequently the humidity of the eastern section will pervade the whole State and a region westward even to the mountains; but this fact will remain, that what the climate of any section in the State has been in the past twenty-five years that it will be during the next quarter century. I speak with a fair knowledge of the literature of this subject and a considerable acquaintance with the agricultural history of our State, and I have no hesitation in saying that there is no warrant in history or local experience for the well nigh universal belief that "deep plowing," "foresting," "turning under the buffalo grass," building "reservoirs" will each or all ever change the agricultural conditions which the settler of any section finds when he begins these and other improvements. The common notion that a change of climate will come as a result of growing more trees and cultivated plants seems to me wholly due to false logic; vegetation is due to climate, and not climate to vegetation.

Except in the case of limited tracts of land flanking large streams like the Arkansas, no general system of irrigation is possible in western Kansas. The water for use for this purpose on an extended scale is wholly or in great part wanting. Such streams as the Smoky Hill, the Cimarron, the Beaver, the Solomon, and their larger affluents might furnish water for irrigation upon a small scale, but the quantity of water *available for this* purpose is sure to be small during the season when it is most needed.

In the lower valleys, where water may be had by means of shallow wells, it would doubtless be possible to practice irrigation upon a considerable scale by means of powerful pumps of the Huffer pattern; but this is at present wholly a matter of speculation. The cost of such pumps and machinery, to say nothing of fuel, puts the system quite out of the reach of the average settler. Moreover, irrigation, even where water for this purpose is ample, is almost certain not to succeed in a region where rains are sufficient for a crop—where, in short, artificial irrigation may be suspended. Artificial watering on a large scale is always expensive. To build dams ditches, and the apparatus of irrigation, and to keep these in repair, involve a very large investment of capital. It is unlikely that the farmer will make this large outlay for occasional use only; but even if the plant has been constructed, it is almost certain not to be in repair for immediate use at the critical time when the rains cease to fall.

The very first thing that the farmer of western Kansas must learn is to take that region, not for what he hopes or dreams it will be, but for what it is. We may not, like the evolutionist, ask and obtain cycles of time in which to demonstrate a theory. He has at his command at most a few years; and even if it were true that the cultivation of the soil may materially effect climate, it is most unlikely that this change would be noticeable in the course of one brief life-time. The settler must then give practical recognition to the fact that the climate as well as the soil of western Kansas, whether better or worse than that of regions further east, radically differs from that of the East. As a result, whatever efforts men may make to the contrary, there will ultimately certainly obtain a different system of agriculture in western Kansas from that practiced in the East. What this system will be must, in so far as details are concerned, be largely a matter of speculation; the general plan, however, seems to have been plainly indicated by the experience of the past few years.

Stock-raising must be the basis of plains farming. Even if grain crops for immediate marketing could be safely counted on it is doubtful whether, considering the remoteness of this section from ultimate markets, and the high price of freights, whether the business can be made a paying one. Moreover, the farmers who have made stock-farming their chief reliance have generally been successful. The men who have been compelled to flee from western Kansas have almost to a man been exclusive grain-raisers. The stockmen have stayed, and, as a rule, they have flourished.

The Eastern idea that a farm of 160 acres is sufficient for the maintenance of a family must, upon the plains, outside of irrigable regions, be forever abandoned. Where outside pasturage is not accessible the plains farmer ought not to limit his operations to a smaller farm than 640 acres, and in most cases 1,000 acres will not be too large. Upon such large farms the native grasses, supplemented with rye and wheat pasturage, and sorghum and corn fodder and millet hay, will keep a herd of cattle or flock of sheep of sufficient size to make a profit from the operations of the farm well nigh certain.

STATEMENT OF AUSTIN P. LOWRY, OF BIRD CITY, CHEYENNE COUNTY.

Having been a former homesteader in this Cheyenne County, Kans., since its settlement in 1885, I feel myself somewhat competent to suggest what is best to be done by aid from the civil government to overcome, in a great measure, the effects of the scorching rays of the sun upon our growing grain. In this county there are numerous streams in which the water flows the entire year, chief of which is the south fork of the Republican River. It enters the county about 5 miles north of the southwest corner of the county, running diagonally to the northeast corner, near where it forms a junction with the north fork.

With the exception of Timber Creek, which only has a flow of some 9 miles, there is no other running water in the county south of the Republican.

The fall of the Republican is said to be 17 feet to the mile, but I doubt if it is even half that much. The average flow of water for the year would scarcely go over 4 feet.

The river is narrow, 150 to 200 feet wide; the valley from 1 mile to 1½ miles wide; the river very generally in the center of the valley with low banks; an abundance of rock and sand along the south side. The difference in the rain-fall in this county is very perceptible.

On each side of the river for some 5 to 8 miles much rain has fallen every year, and the settlers in that line have not had a failure of crops, while those farther from the river have lost their crops twice since 1885.

This fact surely shows the influence of the water in the river upon the atmosphere and consequent rain-fall; hence it is my opinion if five or more dams or reservoirs were erected across the river bottom it would extend the rain-fall all over the county as well as into Colorado and Nebraska.

I believe such dams should be constructed across all these running streams in western Kansas and the surplus water *retained* here. I have no faith in artesian wells.

We see and know what the quantity of water is which flows down these streams, and it is our privilege to detain it, or a portion of it. The General Government should aid the settlers, who are manfully fighting for the subjection of this great plain, and it can not do us a greater benefit than to furnish the money to erect the dams to store this surplus water. The settlers are all in favor of this project, and I sincerely believe it will solve the hot-wind problem in western Kansas and eastern Colorado if carried out.

STATEMENT OF JOHN G. STEFFEE, OF WICHITA.

ARTESIAN WELLS, RAIN-FALL, AND IRRIGATION IN SOUTHWESTERN KANSAS.

Southwestern Kansas is more than 100 miles in length and an average of over 60 miles wide, and comprises nearly 6,000 square miles, or upwards of 4,000,000 acres of land. It is larger than the new territory of Oklahoma, and larger than the combined area of the States of Connecticut and Rhode Island.

It will be admitted without question that the rain-fall in this section is deficient and irregular, and that hot winds actually occur, and at those seasons when the one is most needed and the other most ruinous in their effects.

Let us consider briefly whether the recommendations of the various methods proposed for augmenting the annual precipitation and the conservation of moisture, so often expressed and gratuitously furnished by the residents of the more favored sections of our State, can under existing conditions be put into practical operation in southwestern Kansas. By the term southwestern Kansas is meant all that part of the State lying west of the one hundredth meridian and south of the Arkansas River.

First, there is the current opinion, founded on scientific principles, based on sound reasoning, and not wholly lacking in support of actual experience, that if this vast expanse of level prairie land, reaching out to the horizon in every direction, be broken by the plow of the husbandman and this work supplemented by stirring and pulverizing the deep, rich subsoil underlying the surface, the amount of moisture thus conserved for agricultural purposes would greatly enhance the possibilities of bountiful crops every year.

Now, if $1.50 per acre be taken as the minimum cost of breaking prairie sod, and an equal amount as the cost of subsoil plowing, and if this work is to be supplemented by a thorough pulverization of the soil to the depth mentioned in the report of the experimental station, the aggregate cost of preparing the ground for the first crop would be not less than $5 per acre. But if we admit that the cultivation of one-fourth of the territory, or 1,000,000 acres, would be sufficient to have a desirable and salutary effect upon the annual precipitation and hot winds, and the crops thus produced ample to sustain the population necessary for so great a work, even on this basis the expenditure of labor and money for the first crop would be more than double the assessed valuation of this entire section.

Leaving the question of cost entirely aside, when we inquire into the present facilities for putting this experiment into general practice we find that they are grossly inadequate. Probably not more than 1,000 men who own good strong teams are now actual residents of southwestern Kansas, and with such a meager force as this it requires no argument to warrant the conclusion that successful and profitable farming, or the conservation of moisture by the process described in the report of the agricultural experiment station, is wholly impracticable, and that it is impossible under existing conditions to reclaim the semi arid lands of southwestern Kansas by breaking prairie sod or subsoil plowing.

Referring now to the question of timber-culture, it will not be denied that the planting and cultivation of forest trees has been to a certain degree instrumental in conserving moisture for agricultural purposes, at least in some sections of the State. Our national legislators doubtless had this theory in view when they passed the timber-culture act. But we are informed that not over 20 timber-culture entries have been completed in the Garden City land district, and after examining the condition of trees planted on a large number of timber claims we are clearly of the opinion that very few of the entries made under the provisions of this act will ever be completed, certainly not until there is a second influx of immigration into this section of the State; and even though in the future the climatic conditions should be most favorable to the growth of trees already planted, the influence to be exerted by this means must necessarily be almost infinitesimal as a source of augmenting the annual precipitation.

Then there is another theory, to the effect that if the surplus water which falls during the winter and spring months, also the water produced by the melting of snow, could be in some way impounded and retained till allowed to evaporate under the summer sun, it would greatly increase the humidity of the atmosphere and have *a marked* influence upon the rain-fall later in the season. This theory presents to

our mind a greater semblance of reason than the two preceeding, but as no data have been compiled and no known experiments have been made on which a calculation could be based, and although a general survey of the surface of the country seems to disclose many locations for building dams or dikes, and thus impounding the surplus water, yet the evaporation in this section is so great that unless some means can be devised for replenishing the artificial basins thus constructed the opinion must be that the necessary expenditure of money would hardly be compensated by the benefits accruing therefrom.

Several other theories have been advanced which might be here discussed, but so far as can be learned their demonstration will depend upon conditions almost wholly wanting in southwestern Kansas. Hence it must be concluded that all the theories relative to the subject of increase of the annual precipitation, the conservation of moisture and modification of hot winds, which have heretofore obtained circulation must for the present be discarded, for the reason that their demonstration is impracticable under existing conditions.

There are three elements then which must be combined before we shall discover the key to the solution of the great economic problems mentioned in the first chapter, and which not only the inhabitants of southwestern Kansas but also every person pecuniarly interested in that section of the State are anxiously awaiting a practical demonstration. These elements are:

First. A complete study of the geological formations underlying the surface of the country as described in the State geological survey.

Second. The data compiled with reference to the artesian wells already existing in this section of the State.

Third. A thorough examination of the topography of the territory described.

The first two elements are even now largely matters of public information.*

An artesian well is one in which an artifical vertical shaft is filled to overflowing by water, which enters it at some distance below the surface of the ground. The water may spout up with force and rise higher than the surface or it may barely reach the point at which it flows over. The conditions under which this can occur are the same as those which govern the supply of water to the upper rooms of buildings in cities. The reservoir with which the water-mains are connected must be higher than the place supplied; for the same reason the stand-pipe which takes place of a reservoir in towns located in a level country must be higher than the tops of the highest buildings. This is made necessary by a well-known principle in hydrostatics, that a fluid will not rise in an open tube higher than its source. There are some artesian wells whose flow is due to other than hydrostatic pressure here described, viz, to gas pressure and rock pressure, but these forces need no illustration. In nature the channel through which the water flows is more like a sponge than the orifice of a pipe. It is porous rock, standstone, conglomerate, gravel, sand, or limestone more or less cracked or broken. The walls of the natural pipe must be impermeable and usually beds of clay or clay-shale serve this purpose. To get the head of water the beds of sandstone, shale, etc., must have a dip, *i. e.*, they must be higher at one part than another. The best conditions are when the rock strata take a basin formation, highest on the edge of, circular area, and a well sunk in the middle of the basin. It is to be understood that all the waters of the land are meteoric waters, having their origin in the rains and snows. If, then, the rain falls on porous rock on the upturned edge of a basin, which within the basin is overlaid and underlaid with impervious clays, a well sunk at or near the middle would be artesian.

The basin form is, however, comparatively rare in nature, but continuous dip of rocks in one direction is by no means uncommon, so that the form of a trough is more often found. If the relative position of porous and impervious rocks is the same, artesian wells may be found on the slope or at the lowest point. In southwestern Kansas the general dip of the geological strata is from west to east, as is also the slope of the surface of the country, thus widely distributing the conditions for finding artesian wells.

A brief description of the artesian wells already existing in southwestern Kansas will be useful. Mr. B. F. Cox, who resides on the northeast quarter of section 5, township 31 south, of range 27 west, in Meade County, was the first to find artesian water south of the Arkansas River in Kansas. This discovery was made about two years ago, and since that time nearly one hundred wells have been sunk and are now flowing in Meade County from 10 to 60 gallons each per minute. Nearly every farm in the vicinity of Artesian City has one, and some farms have several. These wells evidently derive their water supply from the Dakota formation, which, as has been before stated, is the stratum from which the deep wells of the high prairies is supplied. The water of the wells is clear as crystal, and is used by the farmers for supplying the troughs in the feed lots and pastures, also for drinking and culinary purposes. Several farmers are preparing to use the water for irrigation next season.

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* Prof. Robert Hay, geologist of the State board of agriculture, furnishes a report on the first topic.

At Richfield, the county seat of Morton County, are two artesian wells to which the water is supplied from a lower stratum, evidently the miocene grit, the lowest of the Triassic series. These wells are 670 and 710 feet in depth respectively. The drill passed entirely through the red beds, which at that point are over 400 feet in thickness. The flow of the first well is over 25 gallons per minute and of the second about 10 gallons, which may be increased to 25 gallons or more by driving the casing down to the Triassic strata. These wells are located on a ridge one-half mile west of the center of the town. The surface of the ground being as high as any of the surrounding territory, and about 75 feet higher than the site of the Morton County courthouse, situated near the center of the town, the pressure is sufficient to carry the water in a 2-inch pipe to the top of the derrick used in drilling, which is 70 feet in height.

We have, then, two sources of artesian water in southwestern Kansas. There is another group of artesian wells at Coolidge, in Hamilton County, which yields from 30 to 100 gallons per minute each, and one at Larned, Kans., having a flow of salt water of 250 gallons per minute.

Other wells are projected and one is now being put down at Johnson City which on the 20th of December had reached a depth of 260 feet at which the water rose in the tube 54 feet.

From these facts we may conclude that a strong flow of artesian water may be readily obtained any where in southwestern Kansas when the drilling is properly done and the shaft sunk below the Triassic strata.

The special aim of this statement is, however, to supply the third element in the group mentioned, to wit, a careful investigation of the topography of southwest section of Kansas.

A cursory survey of the surface of southwestern Kansas from almost every point of observation presents to the view a vast expanse of level prairie unbroken by any apparent elevation or depression, and reaching to the horizon in every direction. But every person who has traveled extensively over this region has doubtless been attracted by the numerous shallow depressions with which the surface is so thickly interspersed. These depressions may be separated into three classes, and that the classification which we shall give may be more readily understood we will in defining and describing them make use of the terms commonly employed by the inhabitants of southwestern Kansas and denominate them as buffalo wallows, prairie sinks and draws, and will define them as follows:

A buffalo wallow is a shallow depression in the surface of the prairie, usually circular in form and from 1 to 10 rods in diameter.

A prairie sink is a shallow depression in the surface of the prairie, either of circular or irregular form and from one acre to several hundred acres in area.

A draw is a narrow, shallow depression in the surface of the prairie, from a few feet to several rods in width, and often extending several miles in a broken and irregular line and opening into a valley or prairie sink.

Having now defined these shallow depressions, it may be proper to explain or at least give an opinion concerning their origin, and in offering this opinion we adopt the views of Mr. Edward Dudley, who resides near the village of Moscow, in the eastern part of Stevens County. In addition to farming and stock-raising he has acted as agent for the United States Wind-Mill Company and has drilled over one hundred and fifty wells in Stevens and adjoining counties within the last two years. Mr. Dudley now resides on a homestead on which is a prairie sink of 50 acres, by which he camped when buffalo hunting thirty years ago. He says he has often seen buffaloes wallowing in these depressions when partly filled with water, and has also witnessed the initiatory work in the excavation of buffalo wallows, which the buffaloes performed by pawing with their feet and tossing with their horns the loose dirt thrown upon the surface by prairie dogs, gophers, and other burrowing animals, and by breaking dawn the surface undermined by the burrows. These small depressions, afterward filling with water, furnished the buffalo a safe retreat from the attacks of buffalo gnats and other insects. He has seen a herd of buffalo make sad havoc with a colony of prairie dogs in a short time. As to the origin of prairie sinks Mr. Dudley has made numerous experiments to determine the depth of the hard and impervious soil with which they are covered and the strata underlying them. He finds the coating of putty-like clay to be from 4 to 10 feet thick, and underlying this is a stratum of sand 50 to 100 feet thick, and in his opinion these depressions were originally beds of quicksands into which flowed the surplus water from a much larger area, each heavy rain having left a thin coating of silt, consisting of gypsum and clay which in course of time became thick enough to sustain the surplus water for a much longer period or until it evaporated under the summer sun. Some of these prairie sinks now furnish water the entire year. They are usually covered with growth of light colored gramma grass and on a bright day the reflection of the sun gives the prairie the appearance of being thickly interspersed with lakes in which the buildings and wind-mills of the *improved farms* are clearly reflected.

In endeavoring to account for the presence of the third class of depressions or draws we would assign the same causes that are usually given for the origin of valleys, *i. e.*, the erosion caused by the flow of surplus water from the surrounding territory. It is a noticeable fact that draws are much more numerous where the soil is sandy and the surface covered with blue stem grass which is of recent origin. In fact many men now residing in southwestern Kansas remember when these sections of country were almost entirely devoid of vegetation, and similar to the sand-hills which yet exist south of the Arkansas River. And it is quite probable that in former times these sandy sections were frequently visited by severe rain-storms, cloud-bursts, and water-spouts, caused by the intense heat arising from the arid soil condensing the moisture in the rain clouds which may have caused the erosion to be much more rapid than under ordinary precipitation.

It will require further investigation to determine even the approximate amount of the surface of southwestern Kansas that is included by prairie sinks and draws. Having located and secured approximate measurement of over five hundred prairie sinks, varying from 5 to 200 acres in area, in Seward County in six days' drive; also a large number of draws which might easily be converted into basins for holding water at very little expense, and from observations made while driving over the other counties of southwestern Kansas the opinion has been reached that they contain an equal number. At present it is estimated that at least one-tenth of the surface of southwestern Kansas could be converted into artificial lakes, providing a sufficient amount of water can be obtained with which to fill them.

And with these data before us a theory may now be presented which if practically demonstrated, will reclaim for agricultural purposes all the so-called semi-arid lands of southwestern Kansas.

If by sinking artesian wells in this region a sufficient flow of water can be obtained to fill the prairie sinks and draws, the whole of southwestern Kansas will be thickly interspersed with a vast number of artificial lakes. The evaporation of the water from these lakes will increase the humidity of the atmosphere, augment the annual precipitation, and dispel these disastrous hot winds. The deceptive mirage will be then a reality. Groves of trees will grow upon the borders of the lakes and the whole country will be converted from a semi-arid region into one most delightful to the eye and the finest agricultural and grazing country on the American continent.

The points of merit which may be justly claimed for this theory are numerous and apparent.

It admits of the employment of all those means which have heretofore been recommended for the solution of these problems. If these draws and prairie sinks can be filled with water, the amount of moisture conserved by breaking prairie sod and subsoil plowing will be greatly augmented. As we have before stated, groves of trees can be successfully cultivated on the margins of these artificial lakes, and whatever modifying influence there may be in the growth of forest trees can be readily appropriated. The theory of impounding and conserving the surplus water which falls in rain and snow is combined and brought within comprehension of those whom it is intended to benefit and relieves the serious doubts as to the influence to be exerted by large basins hundreds of miles distant.

It is not claimed that a sufficient flow of water can be secured to irrigate by the usual method, nor is it necessary to affirm or deny such a possibility. The aggregate flow of the wells in Meade County are sufficient to irrigate at least 500 acres during the severest drought, and those at Coolidge will serve 1,000 acres. Mr. Edward Dudley has irrigated about 5 acres of ground during the past summer by the water from two ordinary wells, and raised an abundance of garden vegetables of all kinds; and the growth of various kinds of forest trees in a small nursery which he supplied with water by this means was truly marvelous. A well like that at Richfield would insure a bountiful crop of vegetables and small fruits any ordinary season on at least 10 acres of ground, and by conducting the surplus to a prairie sink which may be found on nearly every quarter section, it would thus be conserved and allowed to evaporate.

Deep wells have been sunk at Meade, Syracuse, Santa Fé, and Liberal, in which the water does not flow over the top of the shaft. Whether these wells were properly cased when being sunk is not determined. But in no instance does the drill record show that the drill passed through the red beds and into the Miocene grit, as at Richfield. While other wells like these might be the result, even when the most careful work in sinking the shaft, yet, owing to the triumphs of inventive genius, even those difficulties may be readily overcome by the use of irrigation pumps, which are available at a much greater depth than the surface of the water in any of the wells in which a sufficient rise has not been secured.

It may be claimed that if a flow of salt water should be obtained, as is the case in the well at Larned, Kans., it would be injurious rather than beneficial. While unprepared to say that salt water would not be detrimental to the growth of vegetation if used for irrigation, yet the rank growth of vegetation noticed along the margin of the great salt plains of the Cimarron in the Indian Territory is at least one

point in favor of the opinion that salt water would be in no way injurious if used for irrigating purposes. Certainly no objection could be offered if the salt water be allowed to evaporate from prairie sinks, for the salt thus obtained might be a source of great profit.

In fact it is believed that this theory incorporates all the desirable features of those heretofore advanced, and answers every objection that can be raised in opposition to it.

In conclusion it will be proper to make some inquiries concerning the sources from which to secure the proper financial support for the development of the scheme. While many might be named, three only will be referred to.

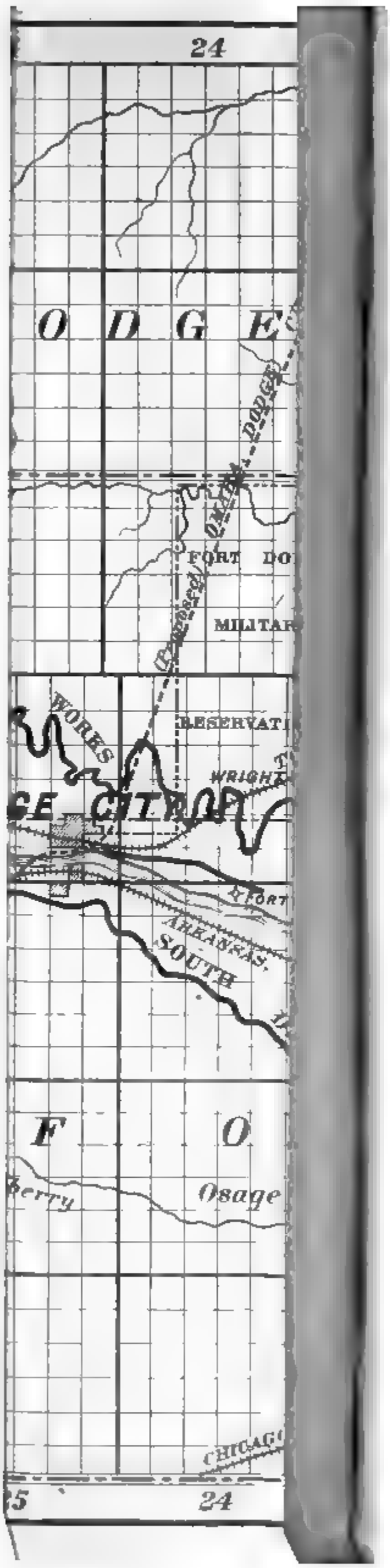
First. By Congressional appropriation. In this connection we will state that although we have confined this discussion to southwestern Kansas, we have done so only for the reason that we have not yet had opportunity to extend our personal investigations over a larger area.

Many arguments might be offered to induce recognition of the claims of southwestern Kansas on Congressional legislation. The United States Government has received from the settlers of southwestern Kansas hundreds of thousands of dollars in payment for lands under pre-emption and homestead entries, of which hundreds have been abandoned for no other reason than that the numerous failures of crops have exhausted the means and blighted the hopes of those who came to this country in good faith and are compelled by force of circumstances to abandon it. It may be said that many of the pre-emption entries were made by single men and others, who had no experience in agricultural pursuits and no intention to improve their farms after completing their entries. While this is true it will be readily admitted that nearly all the farms whose owners were of this class have always been, and are still, for sale at very low prices; and, had this country been blessed with bountiful crops these low-priced unimproved farms would have been eagerly sought after by practical farmers, and the population of the counties of southwestern Kansas, instead of being less than one-third what it was two or three years ago, would be much greater to-day than at any time in their history. Besides, as we have before stated, very few of the entries made under the timber-culture act can ever be completed until there is a marked change in the climatic conditions, and the greater part of southwestern Kansas must sooner or later revert to the use of cattlemen for grazing purposes; and the sugar industry, which promises so much for this country, must be greatly retarded if not eventually abandoned.

Aside from the salt industry which might be developed by sinking deep wells, agriculture and stock-raising are the only resources of southwestern Kansas. No demands will ever be made upon Congress for improvements of rivers or protection of mineral products. Besides, the great West is on general principles certainly deserving of more recognition from our national legislators than it has heretofore received. The second source to which we may look with some confidence is to a union of interests on the part of loan companies and other corporations who have invested largely in real estate and municipal securities in this section of the State. Many of these corporations already realize the necessity of prompt and united action in devising some scheme to prevent a heavy depreciation in the value of their securities and obviate a great loss of money on their own part and that of their patrons. From these two source can sscarcely be hoped a sufficient sum to more than carry the scheme over the experimental stage and sink a few wells in each county with a view of determining the feasibility of the plan. Before the plan can be practically demonstrated it must be prosecuted by those directly interested in its success, which is the third source and the one from which all great enterprises are carried out. The practical demonstration of the theory must depend on private enterprise.

Until the plan is carried beyond the experimental stage we would certainly discourage all efforts to secure money for sinking artesian wells at public expense—and by this reference is made to the questionable methods employed for raising money for public benefits which seem to be practiced to an alarming extent in all the recently organized counties in Kansas. This pernicious practice of issuing county, township, and city scrip for purposes plainly unprovided for by statute and immediately converting the obligation thus ostensibly created into a bonded debt under the refunding act of 1879, should be stopped immediately if the municipalities would escape expensive litigation in the future and private and public credit would be maintained. But if proper influences are brought to bear, and experiments made by those who can afford to lose in case of failure and greatly aid in case of success, then the great work of reclaiming the semi-arid lands of southwestern Kansas can be commenced with some assurance of ultimate success.

The cost of a plant for sinking a shaft to the depth of 1,000 feet is about $4,000, and may be used for years with very little expense for repairs. The one at Richfield cost $2,600. And the cost of sinking the well will depend very largely on the management of the enterprise and the experience of those having control of the work. Upwards of $4,000 was expended by the city of Richfield in attempting to educate local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t in sinking deep wells, and without benefit. But when the enterprise was put r exclusive control of one man who really had the interests of the city at heart, he machinery put into control of a man who had had experience in sinking deep , not in the oil or coal regions of the east, but in western Kansas, the work was y and satisfactorily completed at a cost of $1,000, and a contract promptly let for econd well for one-half that amount.

t it be once demonstrated that artesian water can be found under proper man- ent and at a reasonable cost, and private companies, fully equipped for sinking wells and with employés trained to assist in the work, will spring up. The petition which will follow will reduce the price of sinking wells, and eventually, aggregate cost much less than at present would seem available, these great omic problems of increasing the annual precipitation, conservation of moisture, modification of hot winds will be practically demonstrated, and the vision of the e as herein described will become a reality.

FURTHER STATEMENT OF JOHN G. STEFFEE.

THE UPPER ARKANSAS VALLEY "UNDERFLOW."

thin the last ten years over 500 miles of irrigating ditches have been constructed e Arkansas Valley west of the one hundredth meridian, in Kansas. These es are capable of supplying water for the irrigation of more than 100,000 acres nd in Ford, Gray, Finney, Kearney, and Hamilton Counties; but, owing to the re of the water supply in the Arkansas River for the last two or three years, the es have not been used to their full capacity. This failure of water was caused ly by the paucity of snowfall in the Rocky Mountains in the winters of 1887 and and the severe droughts which have prevailed between the one hundredth merid- and mountains for the last three seasons. We think the current opinion that numerous irrigating ditches which have been recently constructed along the Ar- as Valley in Colorado exhaust the water in the river before it reaches the Kansas is largely erroneous. During the summer of 1889 there was more water in the nsas River at Dodge City than at Coolidge, near the State line. There was at Wichita than at Dodge City, and more flowing water in the channel in the miles in Kansas than in the 200 miles west of the Colorado line.

om records kept at Dodge City during the last eighteen years, and from informa- gathered from other reliable sources, we believe it is safe to depend on an abun- supply of water for irrigation in the Arkansas Valley in at least seven years out n. And we believe that when the snow-fall and rain-fall are sufficient to supply litches in Colorado, the residents of the Arkansas Valley in this State have no n to fear a water famine. If these same climatic conditions are to be looked for e future, would it not be wise to make some provision for these three years of ght? Manifestly so, if the conditions are present which will render such a pro- n possible. For several years past articles have appeared in the newspapers of State discussing various methods of utilizing the underflow of the Arkansas r to supply the irrigating ditches with water which the river failed to furnish ng seasons of deficiency in precipitation. That the supply of water is inex- tible has been frequently demonstrated by pumping water from wells located in valley. The two most noted experiments were made last year at the wells which ly the water-works at Dodge City and at Garden City. These wells are 22 feet 19 feet in diameter, respectively, and about 20 feet deep; the water rises to in 4 feet of the surface of the ground. Over 1,000,000 gallons have been pumped f the Dodge City well in a single day without lowering the water to any ap- iable extent. At the Garden City well the water-works pump, with a capacity 0 gallons per minute, and a Huffer irrigation pump with a capacity of 500 gal- per minute, were both worked to their utmost limit for a period of four hours out lowering the water in the well. Numerous other experiments of a similar re have been made.

hile ditch companies have been repeatedly assured that the underflow of the nsas Valley might be utilized for supplying their ditches none of them had ient confidence in the recommendations to warrant the necessary expenditure of sy to demonstrate its practicability until quite recently.

e South Dodge Canal Company was organized last year with a capital of $250,000. officers of the company are E. E. Soule, president; G. G. Gilbert, vice-president, and . Gilbert, secretary. This company has secured the right of way for 35 miles of irri- g ditch on the south side of the Arkansas River. Fifteen miles of the ditch have ly been completed. It will be known as the South Dodge Canal. Nearly 100,000 of valuable lands may be irrigated by this Canal. The ditch extends from l Station, 8 miles west of Dodge City, to Ford City, a distance of about 35 The original survey provides for taking water from the Arkansas River at

the south bank, opposite Howell Station. It is at the head of the South Dodge Canal that the experiments are being conducted for securing a flow of water in an open channel from a reservoir to which the water is supplied by the underflow of the Arkansas valley.

The reservoir or head of the canal is located about 60 rods from the river bank. At a point one and three-eighths of a mile from the head the ditch was built exactly at grade—*i. e.*, the bottom of the ditch is on a level with the surface of the ground, the bank of the canal being levees about 8 feet high. Commencing at the grade point the excavation of the upper end of the ditch was begun, due allowance being made for the proper fall. At a distance of about half a mile the water-bearing stratum of sand was reached, the bottom of the ditch at that point being about 4 feet below grade. After reaching this sand the soil was then stripped off to the head of the ditch, the work all being done by teams and scrapers. The ditch at a point 2,000 feet from its head is 30 feet wide at the surface of the ground. This increases to 60 feet at the head of the ditch. For this entire distance of 2,000 feet both sides of the ditch are protected by sheet-piling.

The company did not expect to secure a flow of water at this stage of the excavation, but contrary to their expectations the water began to accumulate and run in a strong current down the ditch and in such a quantity that it was necessary to put in a head-gate and cut-off at the grade point 1⅜ miles from the head of the reservoir. The flow extended over 8 miles, and as far as the ditch had been completed at that time. Since the head-gate and cut-off have been put in no water is allowed to pass below it in the ditch, but is turned off at the side of the ditch and runs in a open channel to the river, which at that point is about 100 yards from the ditch. The writer measured the flow of water at the point where it falls over the river bank, and found the stream to be 4½ feet wide and 13 inches deep. It will be remembered that this result has been obtained without any reservoir yet being constructed.

The head of the ditch, as before described will constitute the reservoir, and will be 60 feet wide at the upper end, 30 feet at the lower and 2,000 feet in length. The sand will be excavated by a dredging-machine, which was placed in position on Saturday, February 1.

Owing to the extreme cold weather which has prevailed during a greater part of that month the work of excavating the reservoir progressed very slowly. Over 200 feet was completed by the 7th instant. The excavation was begun at the upper end. Two dredging-machines are in operation, and if the weather is favorable the work will be completed by the 25th of this month. The flow of water has increased largely, and is now fully 2,000 gallons per minute. If the water continues to rise to the same height at which it has been found impossible to reduce it in small wells by pumping, the profile and survey of the ditch provides for a stream of water 5 feet in depth at the grade point before mentioned. The managers feel confident that this supply can be secured.

As an experiment, the work has been a complete success; the water will, and does, flow in an open channel from the underflow of the Arkansas Valley; the channel does not fill with sand, and manifests no disposition to do so.

The Gilbert Bros. have had the general management of the constructing of these ditches. On the 7th the Eureka ditch, 96 miles in length, was full of water, besides over fifty storage reservoirs of from 5 to 40 acres in area. The Dodge City Canal and the Eureka Ditch will both be furnished with reservoirs for supplying water from the underflow of the Arkansas River this season.

*A REPORT ON A PROPOSED PLAN FOR THE IRRIGATION OF WESTERN KANSAS WHEN WATER FOR IRRIGATING CAN BE PROCURED FROM THE UNDERFLOW OF GROUND WATER BY PUMPING FROM WELLS AND DISTRIBUTING BY PIPES.**

PREPARED BY W. TWEEDDALE, C. E., OF TOPEKA.

Observation shows that there are certain districts within the arid subregion where the rain is concentrated in certain months so as to produce a rainy season. When this occurs during the growing period, and the temperature is not too high, less than 20 inches will suffice for "dry farming."

In Texas, with 20 inches of rain-fall, "dry farming" is not profitable; while in Dakota, Minnesota, and Nebraska 16 inches of rain-fall gives good results. The reason for this is that in Texas the temperature is high, and the rain-fall uniformly distributed throughout the year, while in the above-named States the temperature is much lower, and there is a well-defined rainy season giving 72 per cent. of the annual rain-fall during the spring and summer, while Texas has but 50 per cent. during the same time; for which reason 15 inches in the above States will be equivalent to 20 inches in Texas, with the further difference in their favor due to much lower temperature.

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* *This paper* was forwarded as an "advance copy subject to revision" by the *Kansas State board of agriculture.*

The relative value of rain-fall for agriculture in the different localities will appear from a comparison of the tables of rain-fall at eight selected stations in Texas, three in western Kansas, and eight in Dakota, Minnesota, and Nebraska. Of the annual rain-fall of these several stations, the amount that falls during the spring and summer is as follows: In Texas, 55 per cent.; western Kansas, 65 per cent.; Dakota, Minnesota, and Nebraska, 72 per cent.; from which it will be seen that the proportional part of rain-fall in western Kansas during the growing season is intermediate between that of Texas and the above-mentioned three States; and while that in western Kansas is but 11 per cent. less than in the above three States, the difference in effectiveness is much greater by reason of difference in temperature.

In a consideration of the subject of rain-fall, it must be borne in mind that in the so-called "subarid" region there is a great liability for many seasons in a long series of years to be without sufficient rain-fall to make agriculture profitable, in which case the whole supply of water for irrigation must be procured artificially. And as it is the certainty of results alone that will justify the investment of capital in new interprises, it follows that in any scheme for furnishing water for irrigation estimates of cost must be based on being able whenever required to furnish the whole amount of water necessary for the profitable raising of any particular crop. The disregard of ohis rule in the projects for irrigation in western Kansas has been the cause of many tailures.

It is claimed that 336 miles of irrigating ditches have been constructed in Kansas, designed to irrigate 300,000 acres of land, with water procured from the Arkansas River. The amount of water, as per estimate of the State engineer of Colorado, required for grain crops for this amount of land, when the rain-fall was 9½ inches, during the growing season would be 3,000 cubic feet per second; while the average discharge of the Arkansas River at Pueblo during the months of May, June, and July, 1888, was but 2,000 feet per second, and the ordinary flow at Hutchinson in 1876 was but 1,500 cubic feet per second, being but from 66 to 50 per cent. of the requirement. From this it will be seen that the solution of the problem of irrigation for western Kansas must be sought for elsewhere.

It is the universal testimony of settlers in the aforesaid region, that the soil in the river bottoms, which is for the most part sand and gravel, is water-bearing, and that the whole of the Arkansas River valley is underlaid with a vast sheet of water, which can furnish unlimited, never-failing supplies of water at depths not to exceed 25 or 30 feet. The prevalent idea is that the source of this supply is the Arkansas River, and that the completion of the immense systems of irrigating works projected and in course of construction in Colorado will materially affect this supply. In pursuance of this idea, Congressional aid is being invoked to protect western Kansas from so dire a calamity. That this alarm is causeless, and that no fears need be entertained of this result, will appear from the following considerations: Water-works of varying extent, ranging from that of the Croton, which supplies the city of New York, to that of a village of a few thousand inhabitants, have been and are continually being constructed on the basis that in any locality, the rain-fall and physical characteristics being known, a given number of acres of water-shed will furnish a determinable quantity of water. This basis is always used (unless the source, being a large river or lake, is largely in excess of the requirement), whether the water be taken from a pond, a running stream, or where in the dryest season of the year there is little or no water. Thus a pond of 100 acres area, with a water-shed of 500 acres, will furnish precisely the same quantitv of water in one year as 600 acres of contiguous and equally favorable territory where there is no pond, provided that in the latter case the water falling on the surface can be saved for use by means of a dam in a storage reservoir.

In designing storage reservoirs of limited extent, account must be taken of the minimum annual and minimum periodic rain-fall. It sometimes happens that the annual rain-fall continues to be less than the general mean through cycles of three or four years. Computations based on a number of selected stations of largest observation in the United States, extending throughout the whole country, give the average annual rain-fall of the least three-years cycle, at any one of these points, as 67 per cent. of the mean annual rain-fall at the same point, and the greatest three-years low cycle as 97 per cent. of the mean annual rain-fall at the same point. Taking 16 inches as the mean annual rain-fall at Fort Dodge, the mean annual rain-fall of the low cycle will be 67 per cent. of 16, equals 10 inches. Of this amount, favorably situated gathering-grounds of unbroken prairie will furnish at least 60 per cent. This will give a depth of 6 inches of water over the whole area drained for collection in a reservoir. Taking 16 inches depth of water over the area irrigated as the requirement in addition to the proportional part of 16 inches of rain-fall, and we have 16 divided by 6, equals 2⅔; *i. e.*, the water from 2⅔ acres of drainage area will furnish sufficient water

to irrigate one acre of land. Doubling this amount for contingencies (as evaporation and seepage), and 5⅓ acres will suffice for one acre. On this basis the owner of a favorably-situated quarter-section of land can collect in a reservoir the required amount of water to irrigate 30 acres, which will allow 15 acres for agriculture, 15 for meadow, and 130 for grazing. The reservoir should be made deep, to prevent loss by evaporation. Should the gathering ground be large, and owned by a number of persons, a reservoir of greater capacity might be constructed, and by purchase or exchange with each other, a unit of forty acres of irrigable land might be secured to each, with diminished cost per acre.

As the prosperity of a community and nation consists in the land being divided into a great number of well-cultivated small holdings rather than in large tracts owned and controlled by organizations of capital, the above plan will especially apply.

When, however, there is no suitable site for a reservoir, the rain-fall from the gathering-ground will run onto and be absorbed by the porous soil of the bottom lands. Pure sand, when saturated with water, will contain from 30 to 40 per cent. of its bulk, while gravel contains 25 per cent. The eminent scientist, Sterry Hunt, estimates that one square mile of sandstone 100 feet thick will contain, when saturated, water sufficient to sustain a flow of one cubic foot per minute for a period of thirteen years. Sandy soil at a certain depth is always saturated with water, which rises, after large accessions from rain, nearly to the surface of the ground, and falls again during periods of drought. In a region of sand and gravel a fall of 6 feet in the ground-water will give a discharge into the streams of from 40,000,000 to 50,000,000 cubic feet per square mile of ground. The water so held constitutes the reserve which goes to maintain the dry-weather flow of streams.

The water in the ground, like that in the streams, is in constant motion, although its rate is by comparison with that of streams very slow. The quantity of water flowing in an open channel 100 feet wide and 6 feet deep, with a fall of 1 foot per mile, is about 1,000,000,000 of gallons per day. The quantity flowing through a channel of the same dimensions and fall, filled with gravel, will not exceed 600 gallons at the same time. This extreme slowness with which the ground-water moves serves as a regulating sluice to the ground reservoir, securing it against rapid exhaustion.

From the above it is evident that the water stored in the porous soil of the bottom lands is the source of the water supply of the Arkansas River valley, rather than the flowage of the river, which in fact for a portion of the year acts as a drain to the valley rather than as a supply to the under-current. The longitudinal fall of the ground-water in the valley in western Kansas is about 7 feet per mile. The writer found by measurement that the fall of the ground-water from the Arkansas River to Cow Creek, a distance of 2 miles, near Hutchinson, was 8¼ feet per mile. Observations made during the construction of water-works for cities show that in ordinary sand and gravelly soil a fall of 7 feet per mile will give a rate of motion of the ground-water of about 1 foot per hour.

The plans proposed for procuring water for irrigation from the under-ground current, that are said to be in course of construction in the sand hills on the south side of the river, near Fort Dodge, of excavating a large reservoir; and that proposed, of digging an intercepting ditch, and to carry the water thus collected in open ditches to the land to be irrigated, will require that the reservoir and intercepting ditch be made large and very deep, for the reason that the water thus obtained must be procured from above the surface of the water in the reservoir or ditch, with a grade of 7 feet per mile of ground-water to have a rate of motion of water into the reservoir or ditch of even so much as 1 foot per hour. The least allowable inclination of the ditch to carry off the water with a depth of 2 feet will be 3 feet per mile, and as the water collected will be free from silt, the loss from seepage will be very large. Add to this the liability of the carrying ditches becoming filled with drifting sand, and it is extremely doubtful whether, in the case of works of any magnitude, the cost of construction and maintenance may not be largely in excess of pumping from wells.

The question of the supply of any desired quantity of water for irrigation from the underflow being assured, we will consider the subject of its procurement, etc., in the following order: First, the quantity of water required for irrigation, generally and specifically; second, the manner of its procurement from the under-ground current; third, the cost of plant for procurement and distribution; fourth, the results of irrigation and a comparison of it with "dry farming" when the rain-fall is deficient, and also when it is ordinarily considered ample for "dry farming," together with a comparison of the methods in general use of distributing the water from open ditches by means of rills opened and closed with shovels or hoes; and of distributing pumped water from pipes by means of hose and hydraulic monitors attached to plugs or hydrants.

First. The quantity of water required for profitable agriculture depends upon the nature of the soil, character of the crops, and the position of the district in relation to the surrounding country. Thus in the case of a permeable soil with considerable *declivity* the water deposited upon it will pass off rapidly, perhaps even before serv-

for the germination of the seed or the nutriment of the plant. If, however, the be retentive, and the site low as compared with its surroundings, the soil may ome so saturated with water that germination and growth may be greatly impeded. › conditions necessary for the germination of seed and the growth of plants are sture, air, and a certain degree of heat. In a clayey, impervious soil an excess of er will act injuriously by reason of the absence of air and heat. In the case ler consideration, the soil being pervious and the ground having sufficient declivity ive surface drainage, the discharge will be large. Add to this an elevated tem- ature, a clear sky, and dry air—in brief, a normal drought—and we have all the ditions which require frequent and plentiful waterings. In the process of vegeta- ı, water is the medium through which plants obtain nourishment. The water, rged with the organic and mineral substances in a state of solution which consti- › the food for plants, is drawn up through the roots; these substances are assim- ed, and the water thrown off through the leaves. Many experiments have been le to determine the amount of water transpired by plants. M. E. Risler, a Swiss losopher, has recently given a good deal of attention to this subject. He operated ı in the laboratory and by observing the flow from the drains of a field especially nged for such observation. He gives the daily consumption of water for different ls of crops as follows:

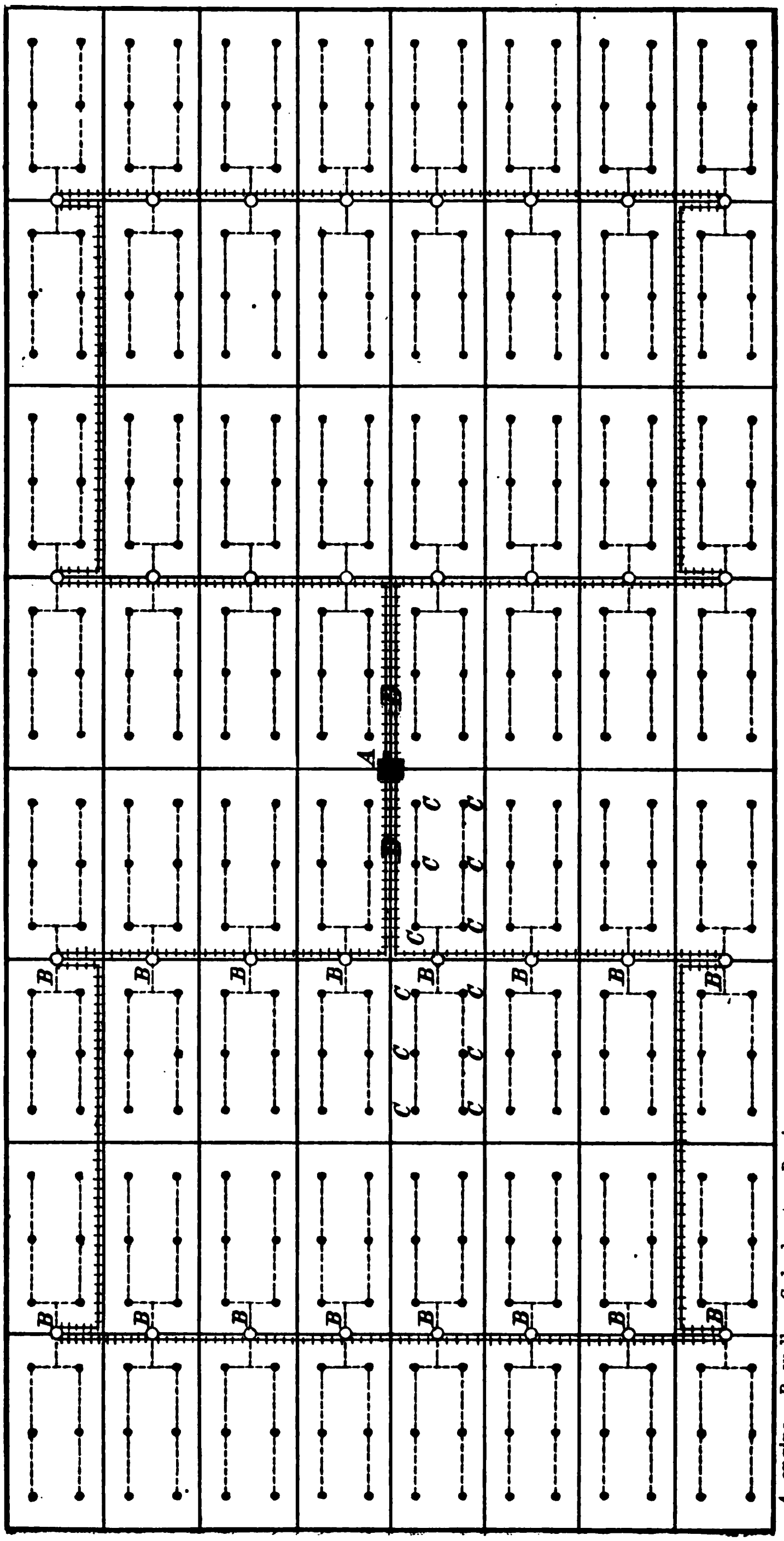
	Inch.		
Lucern grass	0.134	to	0.267
Meadow grass	0.122		0.287
Oats	0.140		0.193
Indian corn	0.110		1.570
Clover	1.140		
Vineyard	0.035		0.031
Wheat	0.106		0.110
Rye	0.091		
Potatoes	0.038		0.055
Oak trees	0.038		0.030
Fir trees	0.020		0.043

chlieden, at Jena, found for a mixture of clover and oats grown in earth con- ıed in an iron box which was weighed at intervals to determine the evaporation, nsumption of about 0.0984 inch per day from the time of sowing until the time of vesting, a period of one hundred and twenty-nine days—13 inches nearly. Very ful experiments on this subject have been in progress for several years at the ervatory of Mountsouris, in France. The grain is grown in earth contained in allic boxes, and similar boxes without grain are used to determine the evapora- ı. In some cases the earth was dried and weighed both before sowing and after vesting. The results obtained were essentially as above given. It was found that roduce one pound of wheat required the expenditure of from 800 pounds to 2,400 nds of water, the lesser quantity being when the soil was fertile. In the case of at the maximum consumption of water occurred at the period of flowering, after ch it diminished to the ripening, and then ceased.

rom the above table it appears that a field of grain (as wheat, oats, or rye) may rb, between seeding and harvesting, 15 inches of water, while grass may absorb nches during a period of growth of one hundred and thirty days. This question of effect of water on fertility explains the difference observed in the yield of different ls of grain at the same time, and of different yields of the same field in different rs. It also serves to explain some points in hydrology, as to the effect of the de- ction of forests on the flow of streams. The table shows that the quantity of er transpired by the leaves of cereals is greatly in excess of that by the leaves of st trees, which proves that the clearing and cultivating of forests do actually inish the quantity of water in the streams. It also explains how lands rich in chemical constituents of certain grains produce large crops with a small rain-fall, n the case of Northern Dakota and Minnesota, where with a rain-fall of but 17 ıes, 30 and 35 bushels of wheat to the acre is not an uncommon yield.

o the above quantity of water, viz, 15 inches for cereals and 37 inches for grasses, amount transpiring through the leaves respectively, there must be added that ıired for evaporation and percolation. This last in the case under consideration depend on the condition of the soil and the frequency of waterings; the applica- of even two inches when the soil was dry would not penetrate to any consider- › depth.

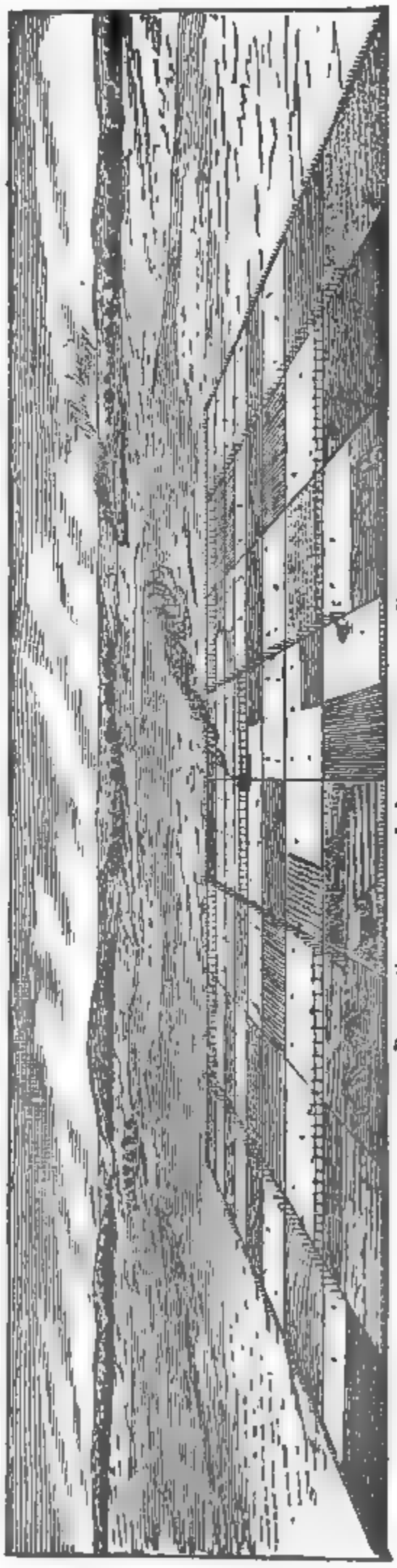
s examples of the quantity of water found necessary for profitable agriculture: fornia, with 15 inches of water, in addition to rain-fall, secures good crops; this s ıty of 206 acres for 1 cubic foot of water per second. A. D. Foot, in his estimate irrigating works in Idaho, gives 100 acres as the duty of the above quantity of er. India, for wheat, uses four waterings of 2½ inches each; this is a duty of 267 s. C. L. Stevenson, civil engineer, gives the duty in Utah formerly as 60 acres,



A, engine. *B*, wells. *C*, hydrants. *D*, pipes.

Proposed plan, showing installation for 1,280 acres, consisting of engine, dynamos, poles, wires, motors, pumps, wells, pipes, and hydrants.

ow of 100 acres. Lombardy, Italy, with an annual rain-fall of 38 inches, 22 of
falls in the growing season, finds it neces-
irrigate, especially for rice and meadow.
es called marcite requires, except when
out, the continuous passage of a thin
water. A cubic foot of water per second
ted 3 acres, thus securing an enormous
The meadows near Milan were cut seven
yielding from 50 to 75 tons per acre per
).
). Schuyler and G. F. Allardt, in their
upon the water supply for the irriga-
Claus Spreckel's sugar plantation in the
ian Islands, state that the customary al-
ce for sugar cane in Spain, Italy, Algiers,
, and Japan is from 45 to 60 acres for 1
foot of water per second; and that the
ger of the Hawaiian Commercial Com-
gave as his experience that for water
d every seven days, when the allowance
cubic foot of water per second for 65
the yield of sugar was an average of 5½
nd a maximum of 10 tons per acre. The
of cane sugar in Louisiana is a maximum
0 pounds, and an average of 2,800 pounds
re, while the yield of sorghum sugar in
a is a theoretical maximum of but 1,400
s per acre.
above large range of water used points
fact that, depending on the crops being
, the more water the larger the yield;
nich reason any scheme for the procure-
of water for irrigation from the underflow
ground in a region of normal drought,
quirements are not only that the supply
ple, but that provision be made to fur-
on call as required. To insure certainty
pply and minimum of cost will require
he water be obtained from wells. These
ions will be satisfied by the use of steam-
pumps, obtaining their supply from a
of tube wells connected to a horizontal
which constitutes the suction-pipe of the
This arrangement, while the first cost
ll, admits of extension as required. As
mple of the successful operation of this
f procuring water in quantity, is that of
ater supply of Brooklyn, N. Y., where,
ne hundred well-points driven to a depth
n 50 to 75 feet, 7,000,000 gallons of water
umped daily. While this method allows
construction of works for the irrigation
desired area of land, the larger and more
ete the installation the less will be the
er acre. With two sections of land as
ea to be irrigated, divided into units of
es each, place the engine and dynamos
center of the area; locate each battery
ls at the adjoining ends of two 40-acre
, the motors and pumps to be portable,
te power to be transmitted by means of
r wires from the dynamos to the motors;
apacity of engine, dynamo, wires, wells,
s, and pumps to be such as to provide for
vering of the whole area of two sections
d with 1 inch of water per week. This
ity of water will serve for ordinary ag-
ure. Should circumstances require an
onal supply the works can be extended
pply adding to the plant.



Prospective or proposed plan, as seen on p

he success of all *enterprises* requires a sound financial basis, and this system,

while adapted to the irrigating of a few acres, is also susceptible of any desired extension, we will consider in what manner it may be put into operation where there is a number of interests concerned, bearing in mind that with the upland range for grazing, 40 acres of irrigated land is a farm.

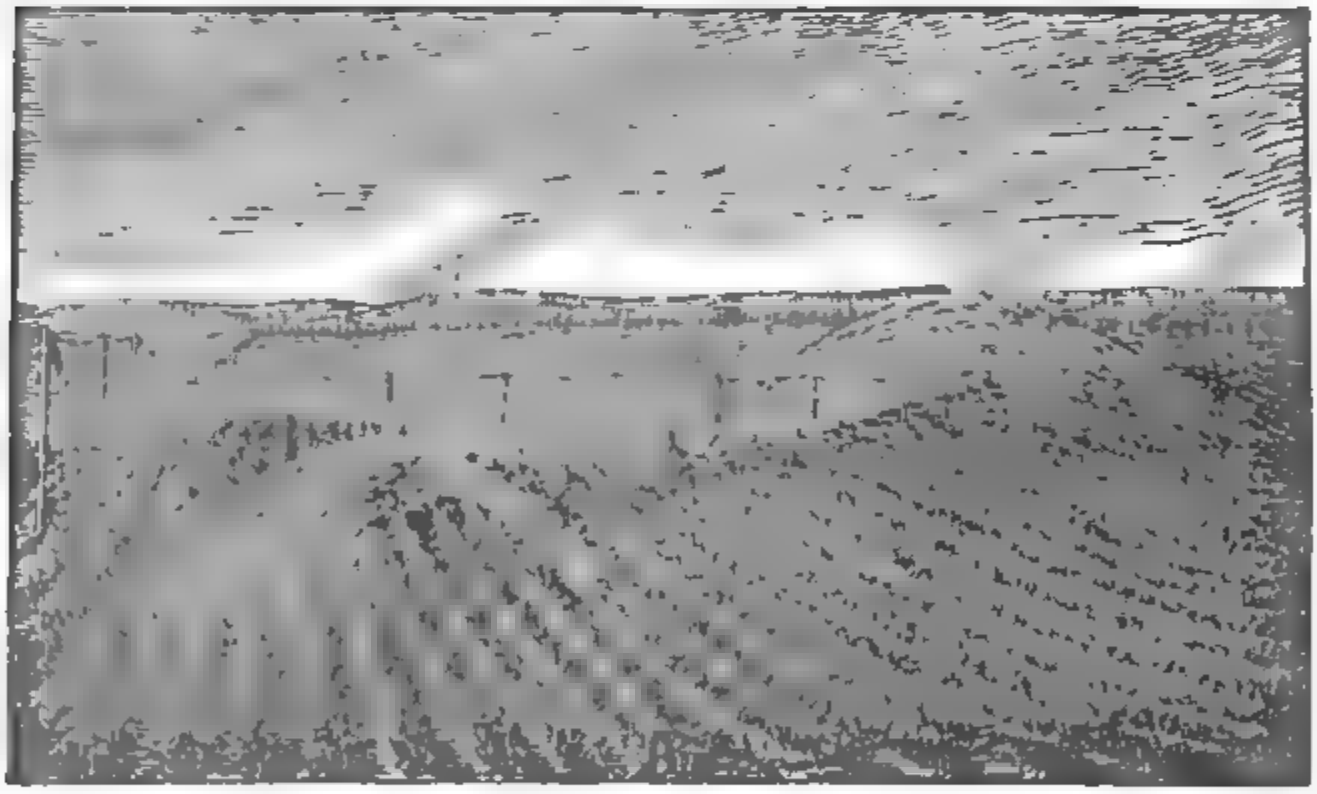
One method might be by the formation of an irrigating district, as is done in cities in the construction of sewers; the whole cost of installation for the delivery of the water at the end of each 20-acre tract to be assessed on the property benefited, and payment extended over a term of years; the works to be paid for in construction bonds. As soon as their nature and value become known, they can be sold readily at a low rate of interest.

Or the works might be put in by a chartered company as contractors, who would be paid a rental as a return for their investment. This rental would entitle all parties within the district to the privilege of obtaining water on payment for the same, which charge would be the cost of pumping and maintenance of plant.

For the installation for an area of 1,280 acres, consisting of a 60-horse power engine, dynamo, poles, wires, insulators, sixteen batteries of wells of fifteen points each, six motors and six pumps, two extra motors and pumps being provided for the purpose of allowing for moving to new stations, thus keeping the pumps running continuously, on the basis of one watering per week of one inch depth of water, each under a head of thirty feet, the cost will be twenty-five dollars per acre. The cost of pumping, consisting of fuel, oil, attendance, and depreciation of plant, will be 12 cents per acre per watering. This delivers the water without waste at the end of each twenty-acre tract.

The distribution of the water may be done, as in the case of that supplied from canals and ditches by hand labor, from lateral ditches; or, preferably, as the water is delivered under a head, by means of a system of pipes, hydrants, hose, and monitors. The cost of distribution will vary with the character of the ground and the nature of the crop, being a minimum for meadow land having a regular declivity, and a maximum in the case of fruit, when, in addition to the regular system of pipes, a line of small perforated pipes is put between the rows of trees.

For two lines of pipes and eight hydrants to each twenty trees, the cost of installation will be about $20 per acre. This, however, allows of the irrigation of land situated



Proposed plan, showing distribution of water from hydrants.

25 feet above the pump, and entirely does away with all labor connected with the construction and maintenance of lateral ditches and the conducting of water over the lands by means of rills. Estimated cost of irrigating by this method will be as follows:

Installation of plant proper for one acre	$25.00
Installation of pipe system	20.00
Total cost of installation	45.00

Interest on above at 8 per cent	$3.60
Sixteen waterings at 12 cents per watering	1.92
Cost of distribution of water, one-twentieth of thirty-two days' labor, at $1.50 per day	2.40
Total	7.92

Contra, for cost of irrigating with supply from canals and ditches:

Cost of water rental per acre	$2.50
Labor, laterals, and distribution, one-fortieth of three men for three months, at $40 per month, per forty acres	9.00
Total cost	11.50

A saving of $3.58 per acre, equal to 45¼ per cent.

The advantages in favor of irrigation are: not only are the crops much larger, but they are entirely unaffected by drought or wet; and being harvested under a clear sky are in good condition, and therefore, being of superior quality, command higher prices. As a rule, persons living on irrigated land, having regular occupation, are more thrifty; their crops are certain, regardless of seasons; having larger and more certain incomes, their earnings are expended in increased comforts—all of which increases the business of railroads. And now that the competition between rival lines has destroyed the profits of through traffic, dependence must be placed on local business, which for that reason must be developed, resulting in the charges for the hauling of coal used for pumping being the least possible. As the effect of an extensive system of irrigation is toward small holdings and a dense population, the result will be increased business. It is estimated that 1 acre of irrigated land produces, directly and indirectly, more than 1 ton of railroad freight annually, or more than two hundred times as much as the same land used for grazing cattle, as the effect of any considerable amount of irrigation would, by increasing the humidity, tend to a reclamation of the unirrigated desert, and in a measure affect the humidity of the whole State; for it is from the desert that the hot winds come that have proved so disastrous to the eastern portion of the State.

Justice would seem to require that some return be made for the benefits rendered, by way of bounty or remission of taxes for a term of years on all irrigating plants and all increased value of irrigated lands. Such aid would greatly promote this industry, and work no injustice to other portions of the State.

While the above proposed plan allows of application on any scale from 1 acre to 100,000 acres, whether by means of storage reservoirs or by pumping, extensions on a scale commensurate with its importance and magnitude may be made by Governmental or State aid with perfect safety, the cost being a lien on the land benefited in a manner similar to that practiced by the British Government in their administration of the affairs of India. In the case of works of improvement that promise to be remunerative the Government takes the initiative, and sends its engineer to make surveys, plans, estimates of cost, and reports as to its character, etc. These reports, with detailed plans and estimates, are sent to the collector of the district, who publishes them and invites objection. If no valid objection is made, the work is done and paid for by the Government, and the cost assessed on the property benefited. If small, it is collected at once; if large, the payment is extended over a period of years. The enhancement of the value of the property by reason of the improvement always precedes the payment of the cost.

The above proposed method of irrigation is but an application of known methods of procuring, pumping, conveying and distributing water; and the mode of transmitting the power, while in one sense new, is of very general application. With an abundant supply of water assured, the merits of this plan are so marked that it would seem that a simple presentation would secure recognition and adoption. The necessity of devising some system of irrigation for the reclamation of so vast an extent of territory of such known fertility, situated in the center of the civilized world, will be seen by a consideration of the methods of developing India by the British Government, in the construction of works of irrigation aggregating millions of dollars of cost, and the resources of Africa awaiting development by them. It was from the then undeveloped Soudan that England obtained the cotton for its factories during the blockade of the Southern ports at the time of the late civil war.

As to the claim that we can not compete in production with the cheaper labor of India and Africa, it must be borne in mind that 40 pounds of coal, costing 10 cents, in a first-class steam-engine will develop 1 horse-power for ten hours, which is equivalent to the labor of five stalwart English laborers, and probably seven or more underfed Asiatics or Soudanese, which, at 30 cents a day, will be $2.10, a saving of $2 on 1 horse-power per day. This saving is not only in the procurement, but also in the distribution, which, apart from the cost, is especially applicable to American methods of doing work by *machinery* and power.

COLORADO DIVISION.

PUEBLO, COLO., *September* 14, 1889.

ıe committee met pursuant to call of the chairman.
esent, Messrs. Stewart (chairman) and Jones, also Director Powell.

STATEMENT OF VICTOR G. HILLS, OF PUEBLO.

ıe CHAIRMAN. We are investigating the subject of irrigation with ence to the water supply, the land to be irrigated, and the crops uced. Will you please give the committee such information as you have touching those subjects, so far, especially, as relates to the e of Colorado or to this county?

r. HILLS. Had I known that I should be examined to-day I should brought with me, as county surveyor, some notes and figures that ve left at my office. I will endeavor, however, to meet your wishes. ıe source of our water supply here is, generally speaking, the ntain streams, the main stream of this county being the Arkansas r. There is one thing which occurs to me to mention in that con-ion; that the flow of the Arkansas is greatest in June and July, h is the time when most water is needed for irrigation. Therefore storage capacity is required to utilize that water than if the greatest were at some other time. That may be said probably of all the ams flowing from the mountains east, across these plains.

ıe CHAIRMAN. Describe the Arkansas River, its dimensions, etc., the quantity of water flowing into it, if you have kept any gauge . State also whether the water now runs to waste, or whether hing can be done to increase the volume at the time needed for ation, both here and in Kansas.

r. HILLS. The Arkansas River has its source near Mount Lincoln, n of Leadville. It may be said here that something could be done e toward turning the waters of the western slope into it if that ld be thought best. I am well acquainted with that particular ity personally. There is a stream tributary to Grand River, which ld probably be turned into the Arkansas at some time, as the water t needed west on account of its streams going into cañons and not g available.

ıe CHAIRMAN. Which one of those streams could be turned?

r. HILLS. There is a tributary which is called the Ten-Mile Creek lue River, which has it source near Breckinridge.

rector POWELL. Do you know as an engineer that that can be ?

:. HILLS. Yes.

rector POWELL. The Grand River will always run to waste where

The CHAIRMAN. It will unless we can make it tributary to the Colorado.

Mr. HILLS. I believe the State of Colorado appropriated something for surveys to determine those questions at the last session of the legislature.

Director POWELL. Where could the Ten-Mile River be tapped and be turned into the headwaters of the Arkansas?

Mr. HILLS. At that portion which is called McNulty Gulch, where the old placer mines were twenty years ago.

The CHAIRMAN. How much of a stream is it there where it can be turned? How much water is there in it?

Mr. HILLS. It is very difficult to guess at the capacity of a mountain stream without knowing its fall. I never gave that question any special thought.

The CHAIRMAN. You can state whether it is an ordinary mountain stream or a considerable one.

Mr. HILLS. It is a good mountain stream.

The CHAIRMAN. Has it a good water-shed?

Mr. HILLS. It has its head in Mount Lincoln and Mount Bross.

The CHAIRMAN. Are there opportunities for the storage of those waters?

Mr. HILLS. I think the opportunities for storage are fairly good. I do not know of any special reason for saying that they are better than ordinary opportunities.

The CHAIRMAN. How many ditches are taken out of the Arkansas River in the State of Colorado?

Mr. HILLS. As to the whole number of small or individual ditches I could hardly make a guess. The State engineer's report would show that fully. Of extensive ditches there are only two that we might call large company ditches now.

The CHAIRMAN. How much land is irrigated from the waters of the Arkansas?

Mr. HILLS. I could not answer that question so well probably as you can get it from some other source.

Director POWELL. I have all those statistics prepared for the committee.

Mr. HILLS. I have not the figures in my mind.

The CHAIRMAN. You have been engaged in engineering for irrigation here?

Mr. HILLS. Yes.

The CHAIRMAN. What is the character of the crops produced?

Mr. HILLS. We can produce almost everything here that grows in a temperate climate.

The CHAIRMAN. You produce, of course, good crops with irrigation?

Mr. HILLS. Yes.

The CHAIRMAN. What amount of water does it require to irrigate an acre of land here—have you paid attention to that?

Mr. HILLS. That is difficult to answer.

The CHAIRMAN. It has been discussed among you here, I suppose?

Mr. HILLS. Yes, it has been discussed a good deal, but the amount of water used by inexperienced persons is well known to be greatly in excess of that actually needed, as was proven in cases where they could not get the water, and as proven by the amount used in dry seasons, like the present one.

The CHAIRMAN. I suppose they waste water here as they always do where they have not had experience.

Mr. HILLS. Yes.

The CHAIRMAN. Some soils and some climates require more than others?

Mr. HILLS. Yes. You will find them to vary here, as we have different soils. We have different soils even in this county.

The CHAIRMAN. I should like to ascertain what efforts have been made to economize water. What is the least amount required to irrigate an ordinary crop?

Mr. HILLS. I could not state that from personal observation. We have not had enough of it. What I would state in that connection would be simply what I have gathered from reading and experience.

The CHAIRMAN. I do not mean to ask you as to the results of your reading and experience elsewhere. Have you had experience of that character here to enable you to state as to this locality?

Mr. HILLS. I have not.

The CHAIRMAN. There is good soil here, I suppose?

Mr. HILLS. The larger part of the soil here east of the foot-hills is excellent soil and capable of cultivation.

The CHAIRMAN. What proportion of it is under ditches?

Mr. HILLS. A small proportion of it—you may say nothing but the bottom lands in this county.

The CHAIRMAN. They have not brought the water to the uplands at all?

Mr. HILLS. No. There is now one ditch building—the Bessemer ditch—that will bring some water onto the uplands.

The CHAIRMAN. You have no idea, I suppose, of the amount of land here that is irrigated?

Mr. HILLS. About three-fourths of the area of the county.

The CHAIRMAN. How much would that be?

Mr. HILLS. I could not tell the area of the county without referring to notes.

Senator JONES. Could water be put on lands in this county with comparative ease?

Mr. HILLS. It can when it is once placed on the mesa lands.

Senator JONES. That is the question. Can that be done?

Mr. HILLS. It can.

Senator JONES. What would be your source of supply, the Arkansas River?

Mr. HILLS. The Arkansas River mainly, but not altogether. We think other small tributary streams in the Greenhorn range could be made available by storage reservoirs, and Beaver Creek from the Pike's Peak region.

Senator JONES. What is the nature of the Arkansas River above here—how far would you have to go to get the necessary fall to take the water out? Would you have to dam the river, and how expensive would the works be, comparatively, to get water enough to irrigate this part of the county which is susceptible of irrigation?

Mr. HILLS. I think we should have to go above Cañon City to irrigate most of the county. That means that we would not have to dam the river, but the water could be brought out by a ditch.

Senator JONES. How far is Cañon City?

Mr. HILLS. Forty-two miles above Pueblo, and just at the place where the river comes out of the mountains.

Senator JONES. Where the irrigable lands begin?

Mr. HILLS. Yes.

Senator JONES. Water could be placed immediately on the land by taking it out up there?

Mr. HILLS. Yes.

Senator JONES. Are you familiar with other parts of Colorado besides this county—the physical features of the country, the possibility of irrigation and the demand for it?

Mr. HILLS. Some parts of it.

Senator JONES. Not generally?

Mr. HILLS. My observation has extended over the counties south of here. Otherwise I am familiar only with the mining or mountain regions.

Senator JONES. Are you familiar with the southwestern part of the State—that portion south of the Arkansas River?

Mr. HILLS. I am, through that portion south of the river and east of the San Juan Valley.

Senator JONES. What is your southeastern county named?

Mr. HILLS. Las Animas County.

Senator JONES. Are you sufficiently familiar with Las Animas County and that part of Bent County south of the Arkansas River to say whether or not any large proportion of those counties is susceptible of irrigation, and whether there is sufficient water supply to irrigate them?

Mr. HILLS. No. I am not sufficiently acquainted with Las Animas County to make any statement in regard to that matter.

STATEMENT OF HENRY R. HOLBROOK.

The CHAIRMAN. What is your occupation?

Mr. HOLBROOK. I am a civil engineer.

The CHAIRMAN. How long have you been engaged in this section of country?

Mr. HOLBROOK. About sixteen or seventeen years.

The CHAIRMAN. Then you are quite familiar with this portion of the State?

Mr. HOLBROOK. Yes. I have been over it considerably. I have been in railroad engineering mostly since I have been in this country.

The CHAIRMAN. You have heard the examination of the previous witness and observed the scope of our inquiries. You may proceed to make any statement which will afford information to the committee with regard to the Arkansas River and to other supplies of water here, the extent of land to be irrigated, and any scheme by which the water supply might be augmented if it is insufficient. Give us a general statement of your information and views on that subject.

Mr. HOLBROOK. Our main source of supply of water for irrigation is the Arkansas River. It is the largest river on the eastern slope of the Rocky Mountains in Colorado. The Arkansas River has a good many branches that carry a good deal of water, especially during the flood season. This water might be stored in reservoirs for the purposes of irrigation.

The CHAIRMAN. Does a large portion of the water of the Arkansas River run to waste?

Mr. HOLBROOK. Yes. The Arkansas River is highest during June and July. That is the flood season. It carries then an enormous quantity of water. That is also the season of irrigation in this country—June and July.

The CHAIRMAN. What proportion of water is taken out by the ditches *in Colorado* during irrigation season?

Mr. HOLBROOK. I do not know how it is as to the whole State. I know only about this vicinity—the Arkansas Valley.

The CHAIRMAN. State the amount of proportion of water taken out by the ditches in the Arkansas Valley in flood times.

Mr. HOLBROOK. Perhaps there is one-tenth of it taken out now during flood time—during June and July—in the Arkansas Valley. I do not know how it is about Denver.

The CHAIRMAN. They do not take the Arkansas out in Denver, do they?

Mr. HOLBROOK. No.

The CHAIRMAN. I am only speaking of the Arkansas River.

Mr. HOLBROOK. About one-tenth, perhaps, of the water of that river is taken out for the purpose of irrigation during flood time. I would not think more than that.

The CHAIRMAN. Is that stored at all, or is it taken out as it is needed and put on the land?

Mr. HOLBROOK. It is taken out in ditches when needed. There is no water stored in this valley now to amount to anything.

The CHAIRMAN. What proportion of the land in Colorado might be irrigated by the waters of the Arkansas that are under ditches?

Mr. HOLBROOK. There is a very small proportion of land in the Arkansas Valley irrigated that might be irrigated. All this land in the Arkansas Valley will produce well if you can get water on it. I never saw an acre of it that would not.

The CHAIRMAN. Is one-tenth of the land under cultivation?

Mr. HOLBROOK. No.

Senator JONES. What do you mean by "the Arkansas Valley;" how wide a tract of country do you include in that term?

Mr. HOLBROOK. The Arkansas Valley extends from the divide, 50 miles north of here, south to the Raton Mountains. That is about 80 miles south.

Senator JONES. About 130 miles wide altogether?

Mr. HOLBROOK. About 130 miles wide. Of course it would not be practicable to irrigate all of that strip.

The CHAIRMAN. What proportion of that could be irrigated if proper ditches were constructed?

Mr. HOLBROOK. Ditches can be taken for, say, 20 miles each side of the valley.

The CHAIRMAN. Could they not be taken out farther than that?

Mr. HOLBROOK. Yes, by going to greater expense; but it would cost so much money to take ditches out farther than that that it would not be practicable.

The CHAIRMAN. Would that strip extend down to Kansas?

Mr. HOLBROOK. Yes; all the way down to Kansas.

The CHAIRMAN. Would it be 40 miles wide all the way down?

Mr. HOLBROOK. Yes; it would not be quite so wide as that at Pueblo. These ditches would diverge from the river.

The CHAIRMAN. But 40 miles wide from the cañon up here?

Mr. HOLBROOK. Suppose you commence at Cañon City, the width there would be nothing. The canals would diverge from the river gradually until they reached, say Pueblo. That would be about 10 miles each side of the river, so that you could irrigate a strip here at Pueblo 20 to 30 miles wide.

The CHAIRMAN. Then it would go on expanding?

Mr. HOLBROOK. Yes; it would go on expanding until you got down

to West Las Animas, say, 80 miles east of here you would irrigate a strip of country from 30 to 40 miles each side of the Arkansas River.

The CHAIRMAN. It would be 60 or 70 miles wide when you got 80 miles below here?

Mr. HOLBROOK. Yes; then these ditches would steadily diverge from the river until you got to the State line. The strip then would be very wide; I do not know exactly how wide.

The CHAIRMAN. When you got down to Kansas you could distribute over an almost unlimited space of ground?

Mr. HOLBROOK. Yes.

Senator JONES. If that system of ditches were already made how would it be about the water supply?

The CHAIRMAN. Yes; suppose you had ditches enough to carry it all the way down to Kansas, what would be the water supply for those ditches?

Mr. HOLBROOK. The present water supply would not be enough to irrigate all that land, but the supply might be increased very largely by storage reservoirs.

Senator JONES. You mean the present water supply—the running streams?

Mr. HOLBROOK. Yes.

The CHAIRMAN. You mean by saving the water of the running streams to be used at irrigation time?

Mr. HOLBROOK. Yes.

The CHAIRMAN. Suppose you saved in reservoirs all that was practicable to save in that way, what extent of land would it irrigate; would it irrigate all this land that it would flow over?

Mr. HOLBROOK. It would not irrigate all the land that you cover with ditches, but of course the amount that could be irrigated would be largely increased; just how much it would be very difficult for me to say.

The CHAIRMAN. If this land were brought under cultivation by reservoirs and other works, would there be any floods in the Arkansas Valley?

Mr. HOLBROOK. There would not be such large floods if the waters were stored and kept back.

The CHAIRMAN. Do you think it is practicable to keep them back so that there would not be floods below?

Mr. HOLBROOK. They could be very much diminished by reservoirs.

The CHAIRMAN. Are you not mathematically certain of it?

Mr. HOLBROOK. Yes.

Senator JONES. You think that if all the water in the water-shed of the Arkansas that could be stored in reservoirs should be stored, there would not be enough water to irrigate all the land in the Arkansas Valley which is between here and the Kansas line?

Mr. HOLBROOK. No. You have more land than you can irrigate. It is simply a question of water supply. All this land east of here will produce fine crops if it can have water; all the crops incident to this latitude.

Senator JONES. But it seems to me there must be a large water-shed in the Arkansas Valley, in these mountains.

Mr. HOLBROOK. Yes; it is a very large basin.

Senator JONES. Have you made any calculations as to the rain-fall in that basin and the amount of water that could be stored, or is this *just an impression* without careful examination on your part?

Mr. HOLBROOK. I never made any careful calculations in regard to it at all.

The CHAIRMAN. You have been over it somewhat?

Mr. HOLBROOK. I have been over it a good deal. I located the railroad line from here to Leadville, and was over it a good deal during location and construction.

The CHAIRMAN. What occasion have you had for examining the water-shed generally of the Arkansas?

Mr. HOLBROOK. I have made surveys from here to the head of the Arkansas River.

The CHAIRMAN. What kind of surveys?

Mr. HOLBROOK. Railroad surveys. I located the line from Cañon City to Leadville for the Atchison, Topeka and Santa Fé Railroad Company, and was also engaged on the construction of the road. I made surveys through Marshall Pass and down to Gunnison.

The CHAIRMAN. Then you have had rather unusual opportunities for observation?

Mr. HOLBROOK. Yes; although I was not observing the country then for irrigation. I was making railroad surveys and locating railroad lines.

The CHAIRMAN. But you observed how the country was?

Mr. HOLBROOK. Yes, and I observed one point, as I now recollect, up there, where I think a large storage reservoir could be made at small expense.

The CHAIRMAN. Where is that?

Mr. HOLBROOK. At the Twin Lakes. That is the finest natural water storage place I ever saw.

The CHAIRMAN. Is the water-shed large?

Mr. HOLBROOK. Very large. It is on a small branch of the Arkansas River, just above Granite. I was up there several times, though not for the purpose of examining its adaptability for a storage basin, but from my knowledge of it I think it is the finest storage reservoir in the world.

The CHAIRMAN. What proportion of the Arkansas River comes out of there in flood time?

Mr. HOLBROOK. I do not know; I could not say. It was quite a large outlet and a very strong stream of water comes out of there, perhaps 20 feet wide and 1 foot deep in low water.

The CHAIRMAN. How is it in high water?

Mr. HOLBROOK. I never saw it in high water.

Senator JONES. How large are those lakes?

Mr. HOLBROOK. I do not know just how large they are. They are several miles long and 2 or 3 miles wide. One is larger than the other.

Senator JONES. How much could the level of those lakes be raised?

Mr. HOLBROOK. I do not know. I should think 20 feet without trouble.

Mr. STANTON. Mr. Holbrook made a survey for a line of ditch on the north side of the river with storage reservoirs, etc. Perhaps he could give the committee some information as to that.

The CHAIRMAN. Was that below here or above?

Mr. HOLBROOK. It commences below—20 miles east of Pueblo.

The CHAIRMAN. Is that as good a place as it would be to commence above—it will not cover so much land, will it?

Mr. HOLBROOK. Yes. Water can be taken out below cheaper than it can be taken out above. The farther down you go the cheaper you can take out ditches, because the bluffs on either side are not so high.

The CHAIRMAN. How is it as to the bottom of the river; is that sand or rock?

Mr. HOLBROOK. Sand usually.

The CHAIRMAN. Would you not select a place where there is a rock foundation to bring the water to the surface?

Mr. HOLBROOK. It would be better if you could, but I do not know of any such place in the Arkansas River east of here.

The CHAIRMAN. Are there not places west coming out of the cañons?

Mr. HOLBROOK. There may be some places west, but the bottom is covered with bowlders for several feet deep, and I do not know that I ever saw a place where the water ran on solid rock.

The CHAIRMAN. But have you not seen places where the rock was not very deep in the channel?

Mr. HOLBROOK. Yes.

The CHAIRMAN. Are you not aware that by taking sandy places you are liable to lose a good deal of water by percolation?

Mr. HOLBROOK. Yes.

The CHAIRMAN. Is it not better to select a rocky spot?

Mr. HOLBROOK. Yes; if you can find the rock.

Mr. STANTON. They do not build dams here as a general thing.

The CHAIRMAN. It is very well to build dams, but it is a good thing to have a rocky bottom.

Mr. HOLBROOK. Undoubtedly, if it can be found. Here, generally, they tap the river at the channel, but it is a little better to tap it 6 inches or a foot below the level of the channel instead of building a dam. Then if there is any water in the river at all you will get it.

The CHAIRMAN. What kind of a head gate do you make in order to regulate the flow?

Mr. HOLBROOK. They are made here usually of timber, say 4 feet wide and 4 or 5 feet high.

The CHAIRMAN. Tell us something in regard to the ditch that you surveyed.

Mr. HOLBROOK. The ditch that I surveyed commences at a point on the north side of the Arkansas River, 20 miles east of Pueblo. It diverges gradually from the river, and runs 100 miles to a point about 25 miles north of West Las Animas.

The CHAIRMAN. How much land does it cover?

Mr. HOLBROOK. In that distance it covers 500,000 acres of land.

The CHAIRMAN. What size is it?

Mr. HOLBROOK. I do not know the size. There has been no construction work done on it yet. It ought to be, I think, at least 70 feet wide at the bottom. In that distance it covers several large natural basins that can be used for storage reservoirs.

The CHAIRMAN. It drops down into a basin and it comes out again?

Mr. HOLBROOK. Yes; the basin becomes filled with water, and from there it is taken for irrigation as it is needed. One basin is 50 feet deep and has an area of 600 acres.

Senator JONES. Is that shown on your map?

Mr. HOLBROOK. Yes, I think it is.

Senator JONES. I see here a place marked that I suppose is a basin.

Mr. HOLBROOK. There is another basin shown there that is 20 feet deep and has an area of 600 acres. Another basin is 35 feet deep and has an area of 3,000 acres. Another basin is 15 feet deep and has an area of 1,500 acres. Another basin is 50 feet deep and has an area of 10,000 acres. Another basin is 55 feet deep and has an area of 4,000 acres.

Senator JONES. Are all those basins high enough to carry the water *on the land* adjacent without raising it by artificial means?

Mr. HOLBROOK. Yes, they might be raised a little, 4 or 5 feet, perhaps, in some places.

The CHAIRMAN. Would it not be more economical to ascertain where the highest ditches could be taken out on both sides, and construct but two ditches, one on each side, and carry all the water in them and discharge it lower down? Would not that be more economical than to have a multiplicity of ditches?

Mr. HOLBROOK. No, I think not.

The CHAIRMAN. I do not mean in the amount of money to be expended, but in the economy of water?

Mr. HOLBROOK. No, I think not. I think it would be more economical to construct a number of ditches, one below the other. If you take out two ditches, say commencing at Cañon City, one on each side of the river, as these ditches are run down the river there is a great deal of water lost by seepage that runs back into the river, and to utilize that water you would have to take out other ditches below. Of the water you take out at Cañon City 75 or 80 per cent. would ultimately get back to the river, and to utilize that again you would have to take out other ditches farther down. Then to take out only two ditches would require very long lateral ditches. Your main ditch might be 20 or 30 miles from the river, and it would take a lateral ditch of many miles to irrigate land down near the river.

Mr. STANTON. Do you know anything about a chance for a reservoir on Beaver Creek, at about Seven Lakes?

Mr. HOLBROOK. No, I have not been up there.

STATEMENT OF O. H. P. BAXTER.

The CHAIRMAN. How long have you resided in Pueblo?

Mr. BAXTER. In this county ever since 1860.

The CHAIRMAN. Are you familiar with the topography of the southern portion of Colorado?

Mr. BAXTER. Somewhat

The CHAIRMAN. That portion drained by the Arkansas?

Mr. BAXTER. Yes, I know something about it.

The CHAIRMAN. What do you say of the Arkansas River as a source of water supply, from your observation?

Mr. BAXTER. We have an abundant supply of water in that river for irrigation in the early season.

The CHAIRMAN. Have you ever thought how much land you could irrigate by it?

Mr. BAXTER. No, I have never figured that up, but we have a very big supply of water in the early spring in this country.

The CHAIRMAN. What proportion of it runs to waste?

Mr. BAXTER. I think almost all of it. The small ditches do not cut much of a figure in the early season of high water, during May, June, and July.

The CHAIRMAN. Very little of the water then is taken out?

Mr. BAXTER. Very little, comparatively speaking. We have not a great many ditches and they are nearly all small.

The CHAIRMAN. Have you been practically engaged in irrigating?

Mr. BAXTER. Yes, many years ago. I commenced farming in 1860.

The CHAIRMAN. What amount of water do you need for irrigation after you have had the ground saturated?

Mr. BAXTER. In the way that we used to take out ditches here, which was a small way, a ditch 4 feet wide at top and 2 feet at bottom would irrigate about 360 acres of a crop.

The CHAIRMAN. You have not arrived at that by actual measurement, I suppose?

Mr. BAXTER. No; not being an engineer I never measured it accurately.

The CHAIRMAN. Do you have a water-master here to distribute water?

Mr. BAXTER. There are water-masters now, but when I was a boy, *in* the early days, we distributed it ourselves.

The CHAIRMAN. You have not done anything with it recently?

Mr. BAXTER. No; I have not farmed for ten or twelve years.

The CHAIRMAN. How much land is there in the Arkansas valley, in Colorado, under cultivation?

Mr. BAXTER. I do not know how much there is—not a large portion. A very small part, in fact, of the valley is under cultivation. I do not suppose there is one-twentieth even of the low valley under cultivation.

The CHAIRMAN. And none of the mesa land?

Mr. BAXTER. Very little. They are doing a little of it now; but heretofore they have been confined to the low lands along the river.

The CHAIRMAN. How does the low land compare in productiveness with the mesa land?

Mr. BAXTER. I do not think it is any better. I think the mesa land is really the better land. It is more easily attended to; the low land is more weedy.

STATEMENT OF W. P. HOBSON.

The CHAIRMAN. How long have you resided in Pueblo?

Mr. HOBSON. I have been here the greater part of the time for eleven years.

The CHAIRMAN. What is your occupation?

Mr. HOBSON. I am a civil engineer by profession.

The CHAIRMAN. Are you familiar with the topography of the watershed of the Arkansas River and the flow of water into and on land to be irrigated by it? Have you given that subject any attention?

Mr. HOBSON. Yes; considerable.

The CHAIRMAN. Please give the committee the results of your observations and experience in that respect.

Mr. HOBSON. I should like to have a suggestion from the committee as to the points upon which they wish me to touch.

The CHAIRMAN. Tell us what you know as to the quantity of water, the means of increasing that quantity, the area of land to be irrigated, the kind of crops to be produced, how much of the water runs to waste, how much of it can be saved, and such other information as you think may serve to give the committee an idea of the situation in this locality.

Mr. HOBSON. There is a very large quantity of water in the Arkansas River at this point on the surface. Below here a very large proportion of the water sinks into the sand. From this point upward there is a very large body of it. There is less volume in sheet water below because it extends much wider the farther down you go. The water on the surface here would certainly irrigate very large tracts of land on either side of the stream if properly handled and properly stored.

The CHAIRMAN. Give us your idea on that subject as fully as you *please.*

Mr. HOBSON. This season I have run a ditch line from Cañon City, n the north sideof the river, to a point on the divide west of the Fount- in (about 85 miles in length) at an elevation of about 500 feet above his point. It crosses the Fountain about 20 miles north of here, and covers an area of probably 200,000 acres of arable land.

The CHAIRMAN. The ditch might be extended farther and cover ıore land?

Mr. HOBSON. Yes, the next 6 miles would probably cover 100,000 eres of land.

The CHAIRMAN. Could it be dropped down from time to time to ıake reservoirs?

Mr. HOBSON. Yes, there are some points where we could make reser- oirs.

The CHAIRMAN. At how much an elevation above the river is the ›wer end of that ditch line?

Mr. HOBSON. It is over 400 feet, and there are basins, of course, over ıat. There are broad, flat areas, that have basins. I do not have ıuch faith, however, in all large flat areas for basins. There is too ıuch evaporation.

The CHAIRMAN. I am not speaking of that, but are there not places here the ground is such as to give opportunities for making deep asins?

Mr. HOBSON. Yes, there are certainly some locations of that kind in hich a great deal of water might be stored for use.

The CHAIRMAN. What is your idea as to whether or not a large por- ion of the Arkansas could be used?

Mr. HOBSON. I think it could be done.

The CHAIRMAN. Did you ever figure upon how much land it would rrigate if you could utilize the principal part of the water that flows own every year?

Mr. HOBSON. No, I have never rated the Arkansas, nor have I ever een an approximate rating. I do not think that even an approximate ating has ever been made of the waters of this river.

The CHAIRMAN. Or an estimate of the land that could be irrigated?

Mr. HOBSON. No.

The CHAIRMAN. That is all to be determined by surveys hereafter?

Mr. HOBSON. Yes, I think so.

The CHAIRMAN. Is it not important, before commencing work and pending a great deal of money, to have that done?

Mr. HOBSON. Yes, I think so, to the extent through which the work s to be applied.

The CHAIRMAN. Ultimately you intend, I suppose, to irrigate all the and that can be practically irrigated by the river?

Mr. HOBSON. We have no intention of doing anything only the matter hat is in hand. I think that the water will all be utilized certainly, ut that is a question for the future. The land is very fertile and very roductive.

The CHAIRMAN. Have you been engaged personally in farming?

Mr. HOBSON. Yes; I have had some experience in that line.

The CHAIRMAN. Give us the benefit of your experience in that respect o far as irrigation is concerned.

Mr. HOBSON. My experience has shown me that a great many persons sed too much water. I have had experiments made with recent crops nd find that they did very well with a small amount of water. I know hat many persons frequently use too much.

The CHAIRMAN. Do not nearly all people use too much when they have an opportunity?

Mr. HOBSON. I think so.

The CHAIRMAN. And by that means they injure their land as well as their crop?

Mr. HOBSON. Yes. A very serious difficulty in connection with storage reservoirs, especially from the saving of storm waters, is the sediments in the water. That is a very serious question in the solution of the irrigation problem. My opinion is that from 10 to 15 per cent of the water from floods in our streams here is sediment. That would be a great trouble when you come to make reservoirs for the storing of flood waters.

Senator JONES. You think the trouble would be that the reservoir would fill up with sediment?

Mr. HOBSON. Yes, I think they would. I made a little reservoir up here, and after a rain I found nearly a foot of sediment in the reservoir. I think the sediment would make over 10 per cent.

Mr. HINTON. Is there no way of sluicing it?

Mr. HOBSON. That might possibly be done, and in that case the sediment would make an excellent fertilizer for the soil.

The CHAIRMAN. Sediment in reservoirs is one of the things that people have been contending with for thousands of years. I think we will overcome that in this country by superior skill, and finally get the mud on to the land. That would make it a great deal better land. The people have been doing that for many years.

Mr. HOBSON. I have thought of that.

The CHAIRMAN. That sediment makes land very rich and perhaps it can be sluiced out. That is one of the problems involved in this great question. High up in the mountains you do not meet with so much difficulty of that kind.

Mr. HOBSON. No, but I think that getting the water from those high reservoirs through the mountains would be a very serious obstacle.

The CHAIRMAN. Through the mountains! You would let it come down by ditches in the proper season of the year. You would not let it come through the mountains.

Mr. HOBSON. The great volume of our high water comes from this slope of the mountain. If you store water up there we will have to get it through the mountains by tunnels.

The CHAIRMAN. Does it not come down now by the river?

Mr. HOBSON. Yes.

The CHAIRMAN. Then what is the difficulty of getting it that way?

Mr. HOBSON. That comes down very gradually.

Senator JONES. The water out of the reservoir would come just as gradually.

The CHAIRMAN. It would not come down to augment the flood. It seems to me there is no difficulty about it.

Senator JONES. The water will come down the stream naturally?

Mr. HOBSON. Yes, but there are the ditches, and the great volume of water that comes down the Arkansas River comes down in these floods and high tides.

The CHAIRMAN. Have you measured the water-bed to know that the larger portion of the water is on this side of the mountain where it could not be stored, or does it not come in ravines?

Mr. HOBSON. I never measured it. I do not think any rating has been made of the Arkansas River.

Senator JONES. You say that they use too much water on the land. *How much* water is it usual to make use of on an acre here?

Mr. HOBSON. Various soils and crops require different quantities of water.

Senator JONES. I know that, but is there any limit to the amount per acre on any kind of land or for any kind of crop?

Mr. HOBSON. My opinion is that a cubic foot of water per second will irrigate 80 acres of ordinary crops after a second or third season.

Senator JONES. That is a good deal of water?

Mr. HOBSON. Yes.

The CHAIRMAN. How much is used here on 80 acres?

Mr. HOBSON. They often use three or four times as much as that, and damage their crops.

The CHAIRMAN. Does this land require drainage?

Mr. HOBSON. Very rarely, and but very little of the land.

The CHAIRMAN. You do not let the water evaporate on the land so as to form alkali, do you?

Mr. HOBSON. There is very little evaporation.

The CHAIRMAN. I mean you do not let it lie in puddles on the land. I suppose it soaks in immediately?

Mr. HOBSON. There is very little of our soil but what has a sufficient slope to carry it away.

The CHAIRMAN. What is the character of the soil?

Mr. HOBSON. The character of the soil is such that it absorbs the water at once. There is very little puddling of the surface.

Mr. STANTON. I think Mr. Holbrook made a statement that on reflection he may qualify; that is, that perhaps one-tenth of the water was utilized in flood-time—the water of the Arkansas River. I am sure that he did not intend to say that.

The CHAIRMAN. He may correct his statement if he pleases.

Mr. HOLBROOK. I do not think there is probably so much. I do not know exactly how much.

Senator JONES. I suppose he meant one-tenth of the water that went down the river in the irrigating season—one-tenth of the normal flow.

Mr. HOLBROOK. That would be the flood-tide of the irrigating season—June and July.

Mr. STANTON. There is certainly not one-hundredth part of the water that flows in the river at that time utilized for irrigation at present.

STATEMENT OF IRVING W. STANTON.

The CHAIRMAN. How long have you resided in Pueblo?

Mr. STANTON. Eighteen years.

The CHAIRMAN. Have you observed the Arkansas River from time to time during that period?

Mr. STANTON. I have generally.

The CHAIRMAN. What do you say of that river as to the supply of water running down it?

Mr. STANTON. In the months of June and July and up into August there is an immense quantity of water usually running in the river.

The CHAIRMAN. What proportion of that water is diverted by ditches for irrigation purposes?

Mr. STANTON. About this point I do not believe that there is the two-hundredth part of the water running in the river above this point used for irrigating purposes, and below this point I do not think there is the one-hundredth of the water used for those purposes.

Senator JONES. For what distance do you mean that?

Mr. STANTON. I mean for the whole State of Colorado. Of course, recently more ditches have been constructed, and a greater proportion of the water is taken out of the river; but when you consider the velocity of the water in the river and of that in the ditches, the amount of water taken in ditches, a few ditches make no perceptible difference whether that water runs in the river or not, because it runs with such velocity in the river channel and so slowly in the ditches. That has been my observation.

The CHAIRMAN. Then, from your observation, you conclude that there is a vast amount of land not occupied that might be brought under cultivation?

Mr. STANTON. I am confident that there is a vast extent of land—all the land for 30 miles on each side of the river as you go east from here—that can be irrigated by water from the Arkansas River, if the water can be stored for the purpose.

The CHAIRMAN. Upon that basis would you stop with the line of the Colorado or would you go along down?

Mr. STANTON. I would go along down (if Kansas wants it) through Kansas. It can be taken through the western part of the State of Kansas just as well.

The CHAIRMAN. Do you think that by storing there would be enough for the whole?

Mr. STANTON. I believe that storage reservoirs could be made so that they would hold an immense quantity. I do not know whether there would be enough for the whole, as there would be a vast amount of water required. I do not think my opinion would be worth much as to that.

The CHAIRMAN. You have been up in the mountains and know generally the condition of that country. What is its condition, and what is its capacity for keeping the water stored up there?

Mr. STANTON. I think there are places where immense reservoirs could be made and immense quantities of water stored for use in irrigating the plains. I think the day is coming when the Arkansas valley will be not only the garden spot of Colorado, but of the whole country. I do not think that any such garden spot occurs anywhere else in the country as is to be found in this valley.

The CHAIRMAN. Would a survey and gauging of the streams be of use in informing the people on this subject?

Mr. STANTON. It would be of immense benefit.

Senator JONES. Have you any idea how much land is in cultivation in the Arkansas valley in Colorado by irrigation?

Mr. STANTON. I have not.

Senator JONES. You could not approximate it?

Mr. STANTON. I do not believe I could, or if I did I do not think my approximation would be reliable. You can probably get that at Denver.

The CHAIRMAN. Have you anything else you wish to say to the committee?

Mr. STANTON. I only desire to say that I am a firm believer in the system of storage reservoirs and I think the actual experience and surveys will demonstrate the entire feasibility of the plan.

Adjourned.

COLORADO SPRINGS, COLO., *September* 14, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman) and Jones; also Director Powell.

STATEMENT OF A. Z. SHELDON, OF COLORADO CITY.

The CHAIRMAN. How long have you resided in the State of Colorado?

Mr. SHELDON. About thirty years.

The CHAIRMAN. Are you familiar with the water supply for irrigation in this State, the succes sof that method, the quantity of land that can be covered by water, etc.? Have you given that subject attention?

Mr. SHELDON. Yes.

The CHAIRMAN. You may proceed and make such statement with regard to it as will aid the committee.

Mr. SHELDON. I have been engaged in the business of civil engineering most of the time while here, and much of the time have, as a matter of course, been dealing with water. I am really at a loss to know exactly what information you desire.

The CHAIRMAN. We want to know what water supply you have, whether it needs to be increased; if so, how it can be increased; the land that you think can be covered by it, whether you have water enough for the land, and whether irrigation is a good thing in this country.

Mr. SHELDON. Water is essential to us here. It is out of the question to depend upon cultivating the soil here without an artificial supply of water. In this immediate neighborhood we are dependent on the water of the Fountain River and the Monument River mainly for our supply. There are several tributaries to the Fountain above, but I include those in the term. I suppose we have some 7,000 or 8,000 acres under cultivation, and if we depend on the natural flow of the water during the season of tillage there is not sufficient to supply that amount of land. Very many persons are short of water during the season. There is, however, taking the season together, in my opinion, water enough flowing here to supply three or four times that amount of land by storing it properly. During the winter-time it virtually runs to waste; there is very little use made of it. During the summer we have copious waterfalls, and, as a matter of course, we have no means of retaining it; so that it flows off.

The CHAIRMAN. What are the opportunities for making storage reservoirs in this vicinity?

Mr. SHELDON. There are several localities in the mountains where reservoirs might be made, but my idea has been to make those reservoirs on the plains. That is further off. If we attempt to make a reservoir on the mountain and then carry it a long distance towards the plains, there is a large loss of water before it reaches its destination. Of course that would contribute to the supply of those in the immediate neighborhood, but it would not sufficiently supply outlying lands. My idea of the proper course to be pursued is to locate those reservoirs at suitable places on the plains and have provision made not only for draining the waters of the stream during the winter to those reservoirs, but for intercepting the rain-fall and storing that. I have seen a single rain-fall here that would fill a large reservoir, and the quality of our land is such that places could be selected where there would be absolutely no loss from storage except from evaporation.

Another feature of the country adjacent to us is, east of us are a system of sink-holes. You understand, I suppose, what is meant by that. Those have for their substratum, you might say, beds of sand. I am satisfied, from my experience, that those sand-beds can be made places for the storage of water. Our experience shows that wherever irrigation is employed springs break out where under ordinary circumstances they never flowed, and they frequently flow along into the winter, sometimes throughout the winter; and if these sand-beds were infiltrated with water I am satisfied that it would constitute a constant source of supply to the stream below, because water in those sand-beds finds its way to the stream. They generally overlie a stratum of alluminous shale which is impervious to the water, and it will flow out to the stream and constitutes a continuous flow. Mr. Nettleton, our former State engineer, made a series of experiments on Boulder River and made careful measurements of water where it leaves the mountains. Although there were no additional streams entering it below that, he measured it some 20 miles below. The water was being determined from the stream by the ditches above and he found a larger flow of water below than came from the mountain; which corroborates the theory that I have advanced here. Any one who has had any experience in the matter will confirm me in this statement that the filling of the earth with water is virtually storing it. East of us there are places where very considerable reservoirs could be constructed with comparatively little expense.

The CHAIRMAN. Are you familiar with other streams than the two you have mentioned?

Mr. SHELDON. I am familiar with the Arkansas River and the Platte.

The CHAIRMAN. We have had no one to give us an account of the Platte, but have had considerable testimony with regard to the Arkansas. Are you quite familiar with the Platte?

Mr. SHELDON. Yes.

The CHAIRMAN. That is dry in summer, is it not?

Mr. SHELDON. After you get some distance from the mountains it is apparently dry, but our streams here are peculiar. Their beds are immense sand-beds and nine-tenths of our streams that appear dry are really full of water which is percolating through the sands. If at any point where the Platte River appears to be dry a permanent dam could be constructed on the bed-rock, there would be a large flow of water intercepted by that dam. But as it is, of course it is not available for irrigation. The expense of reaching it is so large that individuals could not undertake it.

The CHAIRMAN. The waters of the Platte are pretty much consumed above, are they not, in irrigation?

Mr. SHELDON. They are at present. That is, those which appear on the surface. During a very dry time, even in the neighborhood of Denver, the waters of the Platte are very low. I have never seen the Platte perfectly dry, though. I take it that it is never dry anywhere. If the waters which are flowing through the sands could be intercepted, there would be a considerable flow.

Senator JONES. Can that be done?

Mr. SHELDON. I think places could be selected where it could be done. Of course, that is a matter for examination. I never made any special examination.

Senator JONES. That is your conjecture?

Mr. SHELDON. That is my conjecture. I do not know how far below *the surface the* hardpan or firm bottom is, but I know a great many

streams of that character which seem to be dry and yet are carrying a very comfortable body of water.

Senator JONES. What crops do you raise here when you have water?

Mr. SHELDON. We raise all the grains common to farming, vegetables, hay, etc.

Senator JONES. Fruits of some kinds?

Mr. SHELDON. Yes, fruit is quite successful here. If we had water facilities we have as good farming country as there is in the world. There is no question about that.

Senator JONES. What do you say as to the supply of water for Colorado—is it sufficient for the lands you have?

Mr. SHELDON. It is my impression that if a proper system of reservoirs were constructed the entire portion, or almost the entire portion, of that which is known as the plains can be cultivated.

Senator JONES. Would there be some water left that could be used in Kansas, beside?

Mr. SHELDON. It is my impression that it would be a source of supply for Kansas—the storage of those waters. It would increase the flow of those streams which are running toward Kansas, and hence Kansas would be benefited.

Senator JONES. Then you think that with a proper system of storage, that is, if the water were saved and utilized, there would be enough to supply all Colorado and what is required for Kansas?

Mr. SHELDON. It is my impression that if a proper system of reservoirs were constructed on the plains sufficient to retain the rain-fall, which every one who has had any experience in the West knows flows off immediately as it falls, the whole of Colorado and Kansas would be relieved in respect to the water supply.

Senator JONES. Would you regard investigation and survey of this country important, with a view of ascertaining what could be done?

Mr. SHELDON. I most certainly would do so. I have been working up the subject for the last twenty years, making a start. Of course my productions have been merely local here in Colorado, but I have made an effort to attract attention to the subject.

Senator JONES. What do you say of the value of irrigated land for homes? Taking a period of ten years, how will the same quantity of land compare for production with the same quantity of land where they rely on rain-fall?

Mr. SHELDON. I think the advantage is in favor of irrigated land.

Senator JONES. In regularity of crops?

Mr. SHELDON. In regularity of crops and in the fact that you have the disposition of the water in your own hands and can apply it to the crops when they need it, and in the fact that flooding the land with water enriches it—an important factor.

Senator JONES. Has that been the experience in Colorado?

Mr. SHELDON. Yes. I have land which I have cultivated for twenty years successively, with irrigation and without manuring, depending, therefore, on irrigation. Last year I did not see any modification in the crop. I raise from 40 to 70 bushels of oats to the acre every year.

Senator JONES. Successively for many years?

Mr. SHELDON. Yes, and that is a test that tries.

Senator JONES. Has a similar test been applied anywhere around here with regard to wheat?

Mr. SHELDON. I do not know. I raised wheat on one plat of ground for ten years until the prices dropped and then I relinquished it. I did not see any abatement of the crop of wheat for ten years.

Senator JONES. But there was an abatement of the price?

Mr. SHELDON. Yes, the price abated and that abated the growth of the wheat.

The CHAIRMAN. Then, in any crop that you have tried, you have not found that it exhausted the soil at all?

Mr. SHELDON. No.

The CHAIRMAN. Irrigation has supplied nutriment for the soil?

Mr. SHELDON. Yes. I have other lands which I have laid down in grasses. I think I was the first man in Colorado who commenced irrigating the land to produce native grass. I cut grass on the land for twenty years and I have an increasing crop all the time.

The CHAIRMAN. The native grass, without manure?

Mr. SHELDON. Yes.

The CHAIRMAN. How much water is necessary to the land here, after it is fairly reclaimed?

Mr. SHELDON. I have not those figures in my mind. I made several calculations and stored them away; but from 1 inch to 2 inches of water to the surface will constitute a good irrigation.

The CHAIRMAN. An inch under a 4-inch pressure?

Mr. SHELDON. No; an inch or two in depth.

The CHAIRMAN. That is probably about one-tenth of a foot in depth?

Mr. SHELDON. Yes.

The CHAIRMAN. Well, if that is the case, you certainly have water enough.

Mr. SHELDON. We have water enough by storing it.

The CHAIRMAN. There are places where they think they must have a foot in depth.

Mr. SHELDON. There is a good deal of water wasted in irrigation. Many people think they must run floods over the land to irrigate it.

Senator JONES. Do you need more than one irrigation here?

Mr. SHELDON. I used to think that in order to make a crop of wheat about three irrigations were necessary; sometimes, if the season was dry, I used to think four irrigations necessary.

Senator JONES. Then you divide that one-tenth of a foot into three irrigations?

Mr. SHELDON. No; apply one-tenth for each irrigation.

Senator JONES. Then you want more nearly half a foot than one-tenth of a foot?

Mr. SHELDON. About that.

The CHAIRMAN. About 6 inches for the year?

Mr. SHELDON. Yes. That was what I meant to say.

The CHAIRMAN. Is there anything further you would like to suggest?

Mr. SHELDON. Nothing that occurs to me now.

The CHAIRMAN. Where are the places for reservoirs? Are they on public or on private land?

Mr. SHELDON. Most of them are on public land, but those I have in mind are on private land.

The CHAIRMAN. Have you a law for condemning sites for reservoirs?

Mr. SHELDON. We have a law condemning right of way for ditches, and that would naturally carry the reservoirs.

The CHAIRMAN. You have a good law in Colorado.

Mr. SHELDON. It took a long time to get to it, but the people are coming to it now. I made an effort to have them begin as early as 1864 to provide specifically for the distribution of the water.

Senator JONES. If the neighborhood wants some timber the local gent is rather inclined to be kind to his neighbor?

Mr. ENSIGN. Yes; in the forests they are nearly all pioneers. They ant to build corrals and doors and windows.

Senator JONES. Is this question discussed in your pamphlet?

Mr. ENSIGN. Yes, to some extent.

Senator JONES. Do you desire to discuss it further after reflection?

Mr. ENSIGN. Not now.

Senator JONES. I mean will you communicate with the committee if ou think the question needs discussion further?

Mr. ENSIGN. Yes. We will have a bill before Congress, as we have ad nearly every session, for a forestry administration that would in- ude all the public timber land in the United States. By "we" I mean ie American Forestry Congress, which meets again next October. hat body nearly every year has put forward a bill for the preservation f the forests.

The CHAIRMAN. I have seen some of your proceedings, and I find you re taking Germany as a model a good deal. I think you will have to bandon that and take this country as a model, and look at it as it is. ou can not control it here exactly as they do in Germany.

Mr. ENSIGN. I suppose from your reading such volumes and reports s have been published by the Department of Agriculture with respect) foreign systems you are led to believe therefrom that the most we re thinking of is to get some foreign system engrafted on our systems ere.

The CHAIRMAN. I have seen much of the foreign reports reprinted ı our books.

Mr. ENSIGN. We will be quite satisfied here if we can exercise a sort f gentle supervision over the matter.

The CHAIRMAN. I sympathize with that movement. We have seen errible destruction by forest fires. There has been more timber de- troyed this year probably than has been cut for useful purposes since ie first settlement of the West. Fires were numerous in Montana, daho, and Washington. It was so dark that we could not see the ıountains on either side.

Mr. ENSIGN. There is a paragraph in this report published last year ı which I stated that Colorado had for several years been quite free rom forest fires, but that as soon as we had another dry season the ex- eriences of 1879 would be repeated. That came sooner than I thought would, for we have had very disastrous fires this year.

STATEMENT OF GEORGE H. PARSONS.

The CHAIRMAN. You understand the class of information of which he committee is in search. Please state anything that may interest he committee in that respect, especially in regard to the preservation f forests.

Mr. PARSONS. It seems to me that the principal thing in the preser- ation of forests is first to withdraw certain parts of them from sale, o that they can be looked after, then put them under Government su- ervision. That of course would only apply to certain parts of the for- sts that are most important, the headwaters of streams, etc. Then, we should devise some means—I think it would take the wisest heads ı the country to do it, however—to keep down the fires. We have

Mr. ENSIGN. Your question is very vital. That is the thing. The point is to preserve the timber and not prevent the legitimate use of it.

The CHAIRMAN. If they can not have the use of it the country can not be settled. How can it be arranged so that the people may have the timber and at the same time preserve the forests?

Mr. ENSIGN. I think that should be done so long as our pre-emption and homestead laws allow people to take up land of that character that may come on their own claims.

The CHAIRMAN. But you know that in this great interior there are no legitimate homesteads now on the timber lands.

Mr. ENSIGN. There are no agricultural lands, but they take them up under the homestead law for cattle uses.

The CHAIRMAN. There are many fraudulent claims.

Mr. ENSIGN. There are many legitimate ones also. The fraudulent claims are for milling purposes, where they skin the timber off and then leave it. That is where the fraudulent claims come in mostly, I think.

The CHAIRMAN. This has been suggested through Montana and other places where we have been: That all law for the sale of timber lands should be repealed and that the Government retain all timber lands, except where it is seen in good faith to be agricultural. Then let every man have all the timber he requires by paying a small stumpage, which shall meet the expenses of the administration and have local agents that shall have charge of the timbers and prevent forest fires, etc.

Mr. ENSIGN. I think that should be done. People ought to pay enough to keep up the protection of the forests and they would be willing to do so.

The CHAIRMAN. If there is anything further that you wish to communicate after reflection I hope you will communicate it to us.

Mr. ENSIGN. I shall be glad to do so.

The CHAIRMAN. There are two things to accomplish; first it is absolutely necessary that people shall have timber.

Mr. ENSIGN. I know that.

The CHAIRMAN. The next is that the timber shall not be wasted and the forests denuded. Now, how can that be accomplished?

Mr. ENSIGN. I have long known that the people must have timber. The question is how they can so use it as not to destroy it. Let them have the timber crop like any other crop. When it becomes mature let it be reaped. Let it be consumed in some legitimate way without waste, and at the same time prevent the people from destroying all the young timber. That should be preserved.

The CHAIRMAN. That needs local supervision?

Mr. ENSIGN. Yes.

The CHAIRMAN. Would not citizens residing in the locality of the forests be apt to exercise more interest and control than strangers sent in to supervise them?

Mr. ENSIGN. That is a very good theory. If you will pardon me I will tell you what our administration here is. We have a State forest commissioner; then we have county commissioners and overseers. The idea is also that we must interest the people locally; that if the people are not interested the forests will not be saved. That is very nice. It has been my duty to correspond with the county commissioners and overseers all over the State, and I find a woeful degree of indifference, perhaps worse than that where the saw-mill interest predominates, where the public interest seems to lie in the destruction of the forest rather than protecting it.

Senator JONES. If the neighborhood wants some timber the local agent is rather inclined to be kind to his neighbor?

Mr. ENSIGN. Yes; in the forests they are nearly all pioneers. They want to build corrals and doors and windows.

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tried many means in this State, but they do not seem to be efficient. Fire seems to be the greatest cause of destruction.

The CHAIRMAN. Have you any suggestion as the result of your experience to offer to the committee in that respect?

Mr. PARSONS. No, I have not.

Senator JONES. What have you tried in this State to prevent it?

Mr. PARSONS. We have the different county officers, and they have power to get help to put out any fires that they see, and to post notices, etc., and to institute suits for damages.

The CHAIRMAN. Has that been no protection?

Mr. PARSONS. No; none at all. They will not look after it. If a fire starts it is very hard to stop it, and it gets to going before we know it. We have had one case here where the fire started a quarter of a mile from a gentleman's house, in the mountains. He happened to discover it, and it was the hardest thing in the world for him to get it out, although he discovered it shortly after it was started.

Senator JONES. What is the origin of forest fires here?

Mr. PARSONS. Camps and parties through the mountains generally. Regarding storage reservoirs I may be mistaken, but I differ from many others. The forests would store the water just in the same way that the reservoirs would. In fact, they act just as reservoirs do, and in preserving the forests we more or less preserve the waters. There are certain parts of the country which can be reserved without injuring anybody—where people are not apt to go for timber. If those could be reserved it would be of great advantage to agriculture.

The CHAIRMAN. When the forests are removed the water is let down more suddenly?

Mr. PARSONS. Yes, the forests catch it and hold it in the soil. A few years ago the hillsides were all covered with trees; now they are denuded, and when we have rain it is pretty bad.

Senator JONES. I never heard a suggestion that anybody doubted that until to-day.

The CHAIRMAN. I have never heard it stated that if the forests were denuded it would not increase the rapidity with which the streams would discharge the water.

Mr. PARSONS. I have heard people speak of the wisdom of caring for our forests for that purpose.

Mr. CHAIRMAN. I think you will get just as much rain-fall without the forests as ever, but if you have means of storing the moisture below, of holding the water, probably the forests would not be so necessary.

Mr. PARSONS. I have noticed here that the rain-fall is now better distributed. We are irrigating, and are planting more trees around the town sites here and in the country around.

The CHAIRMAN. The rains are less erratic and do not come down so much in spots in this vicinity?

Mr. PARSONS. Yes.

The CHAIRMAN. The rain-fall is modified so that the showers do not resemble cloud-bursts so much as they used to do?

Mr. PARSONS. I do not know about that. I have been here only ten years, but I notice that our showers through the summer come more steadily and I do not think we have had such severe cloud-bursts as we used to have, though of that I have hardly had sufficient experience.

The CHAIRMAN. Have you observed whether the cloud-bursts come *more where there* are few trees?

PARSONS. That is a point that I have never observed. They ally come north of us. I do not think though that there is any dif- ce as to that.

committee ordered filed papers to be forwarded and then ad- ed.

EMENT OF W. N. BYERS, OF COLORADO, AS TO WATER-STORAGE.

[Forwarded by Mr. Ensign.]

re is one plan of water storage which I think has never been publicly dis- l. I doubt if it has been much thought of. It has the merit of being cheap mple whenever the natural conditions will permit of its adoption. In many it can not be used at all. It could not be applied upon the water of Cherry , Plum Creek, Monument Creek, or many other streams that might be named. perfectly feasible upon the head waters of the Arkansas, the Platte, Clear , the Boulders, Cache-a-la Poudre, and all other streams that head high up upon owy Range. The plan is simply to convert the winter flow of water in such as into ice. It can be made to pile itself up into great masses and extensive many feet in depth, sufficient to withstand the sunshine of the entire summer ing. This opinion is based upon an intimate knowledge of high mountain ns and many years' observation of the effect of frost and snow upon them.

t of the longer streams that flow out from the crest of the Snowy Range rise above, the upper line of timber growth. They descend by a steep grade gh the upper belt of timber and a number of them converge toward the center asin which is the gathering point for a large stream. This basin is generally mpy meadow or a thicket of willows filled with beaver dams. Sometimes it is lly covered with spruce trees. In any case it is wet and nearly or quite level. ater flows through it very slowly and a relatively large quantity is always in there. At the foot of the basin a sharper descent begins and a large, well-de- stream is formed. It may further on pass through other basins and lose itself cessive swamps or beaver ponds.

ordinary seasons these high regions are early covered with snow. In many it comes before the ground is frozen at all. It bridges over the channels of the streams and each succeeding storm covers them deeper. Consequently they ll winter under the snow. When the small streams have united and formed the one, it is too wide for the falling snow to bridge over, but the frosty nights soon it with ice, leaving plenty of room beneath for the winter flow of water. soon spreads a blanket over the ice and the stream is safely housed from its at timber line all the way down the mountain slope to the point where chang- mperature brings alternate freezing and thawing. Away up at the head, and ny miles down its course, there is no thawing for many months. Ice once formed ns ice until next summer.

r my plan is to obstruct these small streams at, or just above, where they enter first Alpine basin. It can be very easily done. When the snow has covered he little rivulet and the weather has become freezing cold, break through the ng at a favorable point, pack the channel full of snow and compel the water r over your snow-dam into the open air. The compact body of water that to flowed in its confined and covered channel, now spreads out like a fan, in a heet; it saturates the snow, the freezing air quickly changes it to ice, and in a while a hillock is growing up like the dump at the tail of a ground sluice. And illock, or thousands of them, may be kept growing all winter. They will re- some attention to prevent the water from burrowing a new channel under the but this can hardly happen except during a very heavy storm.

arry out this plan would require an able, trusty man for each given space. It e the basin, or a number of basins at the head of a considerable stream. He make his winter home there. Before winter sets in he will have surveyed the l and marked out his route. It will be nearly on a level along the mountain nd will resemble a trapper's trail for setting a line of traps. He will mark it y blazing trees or planting poles. At the crossing of each little stream he will ine the exact place to interrupt its flow and mark it by a high stake or pole. the proper time comes he will proceed as above explained. During the winter st keep watch of the work, and especially after each considerable fall of snow uld go over his entire circuit. A man should take care of 15 or 20 miles or 0 to 100 little streams. The tools required would be a shovel and possibly a n maul. As may be readily seen, this same process might be applied lower

down the stream where it is larger, and instead of building up a great number of little glaciers, construct a grand one. Success depends upon bringing the water out to the air; distributing it in a thin sheet over a comparatively large surface so it will freeze quickly, and keeping the flow all the time on the surface. To save it all the process must be high enough upon the mountains to have steady freezing weather. Taking the head waters of any one of our important irrigating streams, as the St. Vrain, the Boulders, or Bear Creek, and I believe that one man at $60 per month for six months in the year will store up more water against the next irrigating season than can be stored in a $50,000 reservoir. The plan is so simple and the expense would be so little, that it is certainly worth an experimental trial at any rate.

COLORADO FOREST LEGISLATION AND SUGGESTIONS.

[Forwarded by State Forest Commissioner Ensign.]

By the laws of Colorado the office of State forest commissioner has been instituted, and the county commissioners and road overseers throughout the State are constituted forest officers in their respective localities.

Under the act found at page 299, session laws of 1885, county commissioners and road overseers are made conservators of woodlands in their respective localities, and are required to enforce the laws and regulations made for the protection and preservation of such woodlands.

County commissioners are also enjoined to encourage, to the extent of their power, the planting of trees along water-courses and irrigating ditches, and in other proper places.

It is made the special duty of all forest officers to exercise great care and diligence in the prevention and extinguishment of fires, within the State, likely to endanger or destroy forest growth, and to apprehend any persons who may be guilty of causing such fires; and in the performance of such duties, such officers may call to their aid such person or persons, within the State, as they may deem necessary.

All forest officers and all peace officers, within the State, are empowered and required to arrest any and all persons found trespassing upon the woodlands of the State, or unlawfully cutting or destroying timber thereon, or setting fire in a manner to endanger such woodlands; and shall cause actions to be instituted, in courts of proper jurisdiction, to punish violators of the forestry laws of the State.

Judges of the supreme and district courts and justices of the peace, are by law made conservators of the peace, or "peace officers."

Section 7 of the forestry act also prescribes the mode of compensating county forest officers for services performed under the act.

The session laws of 1885 (page 164) provide for the punishment of persons building camp-fires and failing to extinguish them.

A further act (see page 161, session laws, 1885) makes it the duty of the county commissioners, in each county, to cause to be erected, in conspicuous places, throughout their respective counties, notices in large letters, substantially in the following form, to wit:

"Camp-fires must be totally extinguished before breaking camp, under penalty of not to exceed one month imprisonment, or $100 fine, or both, as provided by law."

Section 3426 of the general statutes of Colorado provides that whenever a line of forest trees, not less than 16 feet apart, shall hereafter be planted, at not more than 8 feet from the outer line of a highway upon which his land may border, or along ditches within his land, and kept in good growing condition for three years, there shall be paid as a premium to such owner of the said land, on the fourth year, and for the next six years following, the sum of $2 for every one hundred trees so planted, provided that said trees be so long kept in good growing condition.

FORESTRY MEASURES PROPOSED.

(1) That a memorial to Congress be adopted, urgently setting forth the immense and increasing destruction of the public forests, in Colorado and adjacent Territories, by fire, railway companies, charcoal-burners, lumbermen, and others, causing great and irreparable injury, and earnestly requesting the enactment of laws to afford necessary relief.

(2) That a liberal annual appropriation be made to the State Horticultural and Forestry Association to aid it in its work.

(3) That arbor day be established by legislative act, and made a holiday in the public schools.

(4) That more substantial encouragement in the way of premiums, etc., be given for the planting of trees. The bounties and exemptions, now provided by law, are *inadequate*.

(5) That railway and telegraph companies, mill-owners, charcoal manufacturers, and others, who consume, in the prosecution of their business, large amounts of timber or other forest material, be required to make reports, in connection with the use and consumption of such timber or material, to the State forest commissioner, as may be called for by that officer.

(6) That the act found at page 161 of the laws of the fifth general assembly, be so amended as to require the continued maintenance of fire notices; such notices to be posted annually, when necessary.

(7) That a law be enacted prohibiting the wasteful use and destruction of young evergreen trees during the winter holidays, or at other seasons.

IRRIGATION AND TREE-PLANTING.

In nearly all portions of the State where water can be had for irrigation, trees can be made to grow. The method or methods, by which they can be grown in certain portions of the plains region, beyond the reach of irrigation, and without the so-called "rain belt," is yet an unsolved problem. It is, however, quite confidently expected that by the introduction of certain hardy foreign species, by the more careful and extended cultivation of some of the native varieties, and by certain prospective experimental work, much may be done to promote the cultivation of trees in the hitherto treeless sections of the State. That crops have been successfully grown in some parts of the plains region without the aid of irrigation, warrants the belief that trees also may be grown there.

PROPOSED NATIONAL LEGISLATION.

In furtherance of a movement to give the State control of such lands, Congress has been memorialized, and the subject more or less agitated by State organizations and individuals interested in the question. The later, and perhaps the better, opinion is, that, owing to the great difficulty of obtaining legislation of that character in behalf of any particular State or States, some general measure should be proposed applicable to the entire body of public timber-lands, wherever situated, and which would leave them under the control of the General Government. Therefore, a bill in accordance with the last-named plan was prepared, and copies of the same sent to leading citizens in different sections of the country for an expression of their opinion upon its merits. The proposed measure met with general favor, and was also heartily indorsed by the American Forestry Congress, at its 1887 annual meeting.

The bill provided for the withdrawal from sale, or entry, of the public forest lands and their classification. It instituted, in the Department of the Interior, the offices of commissioner of forests, and four assistant commissioners; authorized the appointment of necessary forest inspectors and rangers, and sought to establish an effective and reasonably complete forest administration. By a system of licenses for the cutting of public timber, it provided for the needs of settlers and others. Five hundred thousand dollars was named as the amount required to carry out the provisions of the act.

The bill was duly introduced in both branches of the 1887–'88 Congress, but seems to have made but little, if any, progress beyond the committees to which it was referred. A new bill, differing in some important particulars from the old one, will be prepared and introduced at the next session of Congress.

DENVER, COLO., *September* 16, 1889.

The committee met pursuant to call of the chairman.

Present: Messrs. Stewart (chairman), and Jones; also Director Powell.

STATEMENT OF SUMNER H. BODFISH, OF WASHINGTON, D. C.

The CHAIRMAN. Have you made an examination of the topography, the water supply, and the land to be irrigated in the State of Colorado, with reference to the subject of irrigation?

Mr. BODFISH. As engineer assigned to the drainage basin of the Arkansas River, I have had a little experience in searching for reservoir sites in the Upper Arkansas.

The CHAIRMAN. How long were you engaged in that work?

Mr. BODFISH. Since the 1st of July of this year.

The CHAIRMAN. What district have you examined?

Mr. BODFISH. The upper portion, in the vicinity of Leadville.

The CHAIRMAN. Commencing at what point below?

Mr. BODFISH. Commencing at the village of Granite, on the Denver and Rio Grande Railroad and the Arkansas River.

The CHAIRMAN. Have you examined from there up as far as the sources of the Arkansas?

Mr. BODFISH. Thoroughly, and from there below have made prospecting trips.

The CHAIRMAN. State exactly what you found.

Mr. BODFISH. I have found several reservoir sites of the old glacial period of the Upper Arkansas, above the town of Granite, which will store 300,000 acre-feet of water. They are now being surveyed by one of our parties. I have made one trip southward in a wagon as far as Cañon City and across from there to Colorado Springs; and also up and down the Monument and Fountain Rivers, the finding some small sites in the vicinity of Cañon City; also on the Monument and Fountain Rivers.

The CHAIRMAN. Describe the principal sites and the probable amount of storage capacity and the probable cost; not having made an accurate survey, of course, it will be only an estimate. When will you have accurate estimates made?

Mr. BODFISH. Not until the field season is done and I arrive in Washington. The time we use in the field is entirely for prospecting work.

Senator JONES. How late will that be?

Mr. BODFISH. The month of January next.

Senator JONES. You mean you will be in Washington in January?

Mr. BODFISH. I shall be in Washington probably in December, but probably by the last of January I will have those estimates ready.

The CHAIRMAN. Can you give a general statement of what you found?

Mr. BODFISH. Do you mean the reservoir sites and the localities?

The CHAIRMAN. Yes—the principal ones—I do not wish you to go into details.

Mr. BODFISH. Some of them will be rough guesses.

The CHAIRMAN. You can qualify your language as you choose.

Mr. BODFISH. The first site surveyed was that of the Twin Lakes in the vicinity of Granite, in which we find about 108,000 acre-feet, upon the supposition that it was dammed to a height of about 30 feet and drawn off to a depth of 40 feet below the existing surface of the lake.

The Clear Lake reservoir site on the next stream to the south would, at comparatively small cost, store 7,000 acre-feet.

The next area already surveyed is what I called the Hayden reservoir site, on the main Arkansas stream, with a dam, within about 2 miles of Twin Lakes. That has a natural basin out of which the river would cut its way, and it would constitute a storage basin of about 60,000 acre-feet.

The next one, which is now being surveyed, is what I called the Sugar Loaf site, on the lake fork of the Arkansas River west of Leadville and consists of two dead glacial lakes, the water of which had cut its way out. By restoring the natural dam at the lower lake some 50,000 acre-feet can easily be stored.

To the northward of that is found what I call the Tennessee reservoir site, on the Tennessee fork of the Arkansas River, a few miles only from *Leadville* and about 2 miles from the Sugar Loaf site. Roughly esti-

mated, I would say that the Tennessee reservoir would hold at least 50,000 acre-feet.

To the northward of that, about 2 miles is another site which would hold about 3,000 to 4,000 acre-feet. It is called Crane's reservoir site.

In the vicinity of Leadville, within about 1½ to 2 miles of it, is a narrow gulch on the east fork of the Arkansas river which, when dammed, I think would hold something like from 10,000 to 15,000 acre-feet.

The CHAIRMAN. Those are the principal sites?

Mr. BODFISH. Those are the principal sites.

The CHAIRMAN. You may state roughly the probable cost of dams and the kind of structures required to improve those sites.

Mr. BODFISH. I have not had time to make estimates of that or to compute the cubical contents of those accurately. Those three that I surveyed were accurately given. The others were simple estimates. I should say that those sites could be improved at a cost of about $7 to $8 per acre-foot.

The CHAIRMAN. State whether those would be more than ordinarily expensive or not in the construction.

Mr. BODFISH. In the Twin Lakes Reservoir site, the stream has cut out through a natural dam, which is composed of small glacial drumlins or hills with slight hollows between. The masonry portion of the dam at Twin Lakes would be 70 feet high, provided the lake was drained 40 feet below its present surface and raised 30 feet above its present surface. The masonry portion of the dam would be not over 100 feet wide, including the overfall and waste-way. The remainder would be small earthen embankments on the tops of these hills, the greatest not over 100 feet long and 10 feet high. The Clear Lake Reservoir site is also a natural embankment or dam, through which the river has cut to the depth of about 50 feet. The copage at the bottom is about 75 feet across, sloping to about 250 feet on the top of the dam.

On the Hayden Reservoir site I assumed that because the situation was so favorable, a dam to the height of 120 feet.

The CHAIRMAN. Is the copage narrow?

Mr. BODFISH. It is about 400 feet wide and is precipitous almost on both sides to a depth of 90 feet. On one end it rises fast, and on the other it slopes off to a piece of land between the river side and the neighboring creek. The waste-way would be over the natural rock bed at an elevation of 95 to 120 feet.

The CHAIRMAN. Can you describe the kind of a waste-way needed in the other?

Mr. BODFISH. No: they are all glacial drifts.

The CHAIRMAN. And you have to have the water go over the dam?

Mr. BODFISH. Yes.

The CHAIRMAN. That is much more expensive in the building of the dam, I suppose, is it not?

Mr. BODFISH. Yes. On the Sugar Loaf Reservoir site, where the water has cut through the natural dam, the masonry and overfall would have to be built, including waste gates of about 100 feet in length. The remainder could be of earth. I estimated the height of that to be 45 feet. In the case of the Hayden Reservoir site, I should have said that there are two railroads to be moved. In the case of the Tennessee Reservoir site, the dam would have to abut against a glacial drift and would be a length of 600 feet over all.

The CHAIRMAN. Would the overflow have to be over the dam?

Mr. BODFISH. Yes.

The CHAIRMAN. There are only two of them in which the overflow would be over the dam?

Mr. BODFISH. There is only one in which the overflow would be over the solid rock.

What I call the Leadville reservoir would be caused by damming a narrow gorge through solid rock where the walls are perpendicular, only about 75 feet apart and about 60 feet high. Above that, the masonry could be carried as high as 90 or 100 feet and then by some embankments 200 or 300 yards.

The CHAIRMAN. What proportion of those reservoir sites would be on private lands?

Mr. BODFISH. They are almost all on private lands. It happens on those sites that the basins are natural basins, the land is irrigable land, and the people are settled on them. They have excellent farms on the Tennessee basin, and raise sufficient hay to give them an income on some of the farms of $3,000 a year for 160 acres.

The CHAIRMAN. Have you, in each case, a general estimate of the amount of property that would have to be condemned?

Mr. BODFISH. In the maps of those reservoir sites that are being made, all culture and improvements are recorded—railroads, fences, ditches, everything in existence that was put there by man. The topography is taken around the immediate outlet of the reservoir site. Two-foot contours, to enable careful estimates of construction on high-water lines, are run around the remainder of them.

The CHAIRMAN. Have you made any exploration of the land to be irrigated by the water that is stored?

Mr. BODFISH. Not yet. The Arkansas Valley is about 200 miles in length, from Cañon City to the Colorado and Kansas line. If you take 1 mile wide of that valley for that distance, you get approximately 128,000 acres. You can see how much land could be covered in that valley by the 300,000 acre-feet of the upper portion. The drainage area to furnish the water for these 300,000 acre-feet is approximately about 360,000 acres.

Senator JONES. You have examined all the sites above Cañon City?

Mr. BODFISH. No, sir. I have only made one prospecting tour in a wagon from the lower end of this glacial area down the river to Cañon City and across to Colorado Springs. I have surveyed the Fountain River and the Monument Creek, near Colorado Springs, for reservoir sites.

Senator JONES. How much is embraced in the drainage basin of the Arkansas above the lowest point to which you have made complete examination?

Mr. BODFISH. About 360,000 acres.

Senator JONES. What proportion of the rain-fall embraced in that basin would be caught in those reservoirs?

Mr. BODFISH. It would all be caught.

Senator JONES. There would be no waste of water of that 360,000 acres at all if the reservoirs were built?

Mr. BODFISH. No, sir; they would be sufficient. The rain-fall in the Arkansas River is now being determined and the streams will be gauged by the hydrographic force. That information has not been furnished to me yet. So I can not state how much water there is.

Senator JONES. I did not ask about the quantity of water, but whether the reservoirs would catch all the rain-fall within that basin?

Mr. BODFISH. Yes; they will catch all the rain-fall within the 360,000 acres, and they furnish about 300,000 acre-feet, of storage room.

Senator JONES. As to the water supply, that will be ascertained when you find out the rain-fall?

Mr. BODFISH. Yes.

Senator JONES. How much will all those reservoirs irrigate?

Mr. BODFISH. About 300,000 acre-feet, 300,000 acres of water 1 foot deep.

Senator JONES. I think the rain-fall would be very much more than a foot.

Mr. BODFISH. I presume it will, but on the assumption that you can store those full twice a year you can have a good deal of water. The rain-fall, with the melting of the snows, would fill them before spring, and when the farmer wants them, in April, May, and June, they can be emptied, and filled again with the melting of the snows in June and July, which would be used again in the fall, on the supposition that there is rain-fall and snow-fall enough to fill them twice.

Senator JONES. About how much land do you think (by refilling) could be irrigated if you got enough to fill them twice?

Mr. BODFISH. You would have 600,000 acre feet.

The CHAIRMAN. They do not need more than 6 inches of water.

Senator JONES. His proposition is to irrigate twice a year.

The CHAIRMAN. Six inches of water for a year will be enough when the people are reasonably economical.

Mr. BODFISH. I have found three small sites on the Fountain and Monument Rivers. I have found one in the vicinity of Cañon City. From my knowledge of the topography and looking into the country from a distance, I think there are many more in the vicinity of Cañon City and Pike's Peak.

Senator JONES. How near will you be able to complete the examination of your whole district this season?

Mr. BODFISH. I think I can do it all before the end of the season as far as reservoir sites are concerned.

The CHAIRMAN. Do you contemplate sites on the plains?

Mr. BODFISH. There are some sites there, I understand, and which I am told are good, and will carry a good deal of water, but I do not know about that until I investigate.

STATEMENT OF H. B. CHAMBERLIN, OF DENVER.

The CHAIRMAN. What is your occupation?

Mr. CHAMBERLIN. Investment banker and real-estate dealer.

The CHAIRMAN. You are president of the Chamber of Commerce?

Mr. CHAMBERLIN. Yes.

The CHAIRMAN. Have you given the subject of irrigation and water supply for land in this State any attention?

Mr. CHAMBERLIN. I have given the matter some practical but not theoretical attention.

The CHAIRMAN. Please state in your own way what practical attention you have given the subject, and what conclusions you have arrived at.

Mr. CHAMBERLIN. My interest in the reservoir question is in the ownership of land adjoining a reservoir built in 1884. I purchased of the Union Pacific Railway in 1882 the northwest quarter of section 12, township 5, south of range 69 west, for $7 an acre. In 1883, this land was held at $10 an acre without a buyer in the open market. No improvements had been made thereon. In the autumn of 1883, W. C.

Henry, the owner of the southeast quarter of section 4, township 5, south of range 69 west, built a reservoir covering 80 acres on said quarter section, this reservoir being completed by the following spring. Within three months of the time this reservoir was completed this land of which I was the owner was sold by me for $25 an acre, the appreciation in value being wholly due to the fact that the reservoir had been built of sufficient capacity to furnish water for the adjacent lands.

During the whole of my ownership that land was under a ditch known as the "Agricultural Ditch." No water could be had for the land, the entire water right being exhausted, so that the stored water referred to enhanced the value of this land within six months from $10 an acre, with no buyers, to a sale at $25 an acre. During this time no improvements of any kind had been put on the land.

The CHAIRMAN. What has been the practical result of that reservoir to you which furnished water for irrigation all that time?

Mr. CHAMBERLIN. That land has been under cultivation ever since, and is now worth $100 an acre.

The CHAIRMAN. From that reservoir?

Mr. CHAMBERLIN. Yes.

The CHAIRMAN. Explain what water it gave and how much land it covered. Give an idea of the cost of the reservoir and its practical results.

Mr. CHAMBERLIN. From time to time this reservoir has been enlarged by heightening the wall that confined the water in a sink, so that from being able to store water to furnish about 400 acres the reservoir is now able to furnish water for an estimate of 1,200 acres.

The CHAIRMAN. How much land is flooded?

Mr. CHAMBERLIN. I think now about 120 acres.

The CHAIRMAN. What is the height of the dam?

Mr. CHAMBERLIN. It must be 14 feet high.

The CHAIRMAN. How is the reservoir supplied with water; what is the water-shed that supplies it?

Mr. CHAMBERLIN. It is not a natural water-shed. It is water stored during the unused season from the Agricultural Ditch.

The CHAIRMAN. The water runs to waste from that ditch and you turn it into a reservoir.

Mr. CHAMBERLIN. Yes.

The CHAIRMAN. And by making that reservoir you have succeeded in irrigating about 1,200 acres that could not have been supplied.

Mr. CHAMBERLIN. We saved water in that to irrigate the 1,200 acres.

Senator JONES. Has the owner of that tract of land bought a permanent interest in the water-right or does he get it annually?

Mr. CHAMBERLIN. He has bought an interest in the stored water of this reservoir, not in the water-right, not in the ditch; he could not buy a right in the ditch; nobody would give up, but he bought a right to the water stored in the reservoir.

Senator JONES. What did the water cost him?

Mr. CHAMBERLIN. I do not know. I think that another witness later will know.

The CHAIRMAN. What is the character of the soil? Is it different from what it is on the plains generally?

Mr. CHAMBERLIN. No, not at all. There is a little more adobe in it.

The CHAIRMAN. Is not that good for reservoir sites?

Mr. CHAMBERLIN. Yes; the reservoir site is sandy and adobe-like, having a little more adobe than the soil east of Denver.

The CHAIRMAN. Have you made record of the evaporation?

Mr. CHAMBERLIN. No. Not having interest in it now I have not done so.

The CHAIRMAN. How long did you have to retain the water before using it?

Mr. CHAMBERLIN. The first season it did not hold; the second season it did.

The CHAIRMAN. After you got it puddled so that it would hold water, how long a time elapsed from the time of filling the ditch before you could use the water?

Mr. CHAMBERLIN. The filling was done during the winter and early spring and every time there would be a little water going to waste the commissioners would allow it to be turned into this lake. The water was not all used that was coming through the ditch. There was water coming constantly through until the dry season commenced, about the middle of June.

STATEMENT OF LOUIS G. CARPENTER, OF FORT COLLINS,

The CHAIRMAN. What is your occupation?

Mr. CARPENTER. I am professor in the State Agricultural College.

The CHAIRMAN. Have you given the subject of water supply for irrigation some consideration?

Mr. CARPENTER. I have traveled a good deal in the summer, investigating irrigation in Colorado. In connection with my duties, I have been over a good many thousand miles. I have traveled probably 800 or 1,000 miles over the ditches themselves.

The CHAIRMAN. Give us briefly the result of your investigation.

Mr. CARPENTER. Some features that I have met with in the eastern part of the State may not have been called to your attention, especially as to the Platte River. It has struck me many times that while the Platte River up here has been nearly dry, with very little water in it for many miles, the lower ditches have not suffered for want of water, although the same ditches have used nearly all the water. I understand that the greatest water supply at any one time in the Platte River has been 600 cubic feet per second.

Senator JONES. Where did those lower ditches get their water supply?

Mr. CARPENTER. From the Platte almost entirely. They have been aided somewhat this year from side streams. As you know, throughthe plains there are streams that are ordinarily dry, yet the total water supply from them is large in one sense. As a special instance, there is the Bijou, which enters the Platte near Fort Morgan. It has several times this summer come down with a rush and has supplied a good deal of water to the Platte in the region below. It has helped out the Platte and Beaver very much. One special instance was told me by the superintendent of that canal, with whom I went over the canal. He heard the flood coming down the canal and went up to protect the ditch. The water came down that channel a good many feet wide and 3 or 4 feet deep, sufficient to cover all the highlands outside. The water commissioner of that district corroborated that statement and also stated that the water ran for nearly twenty-four hours. He further stated, as showing the effect of the Platte, that the water commissioner of the district below told him that although they ran for twenty-four hours, it did not affect the water supply at Sterling or on the Pony Ditch, which is some miles below. All the water had disappeared in the sands. The disappear-

ance and re-appearance of the water in the sands is rather surprising. I have not verified that, but it shows something of the characteristics of those streams.

The CHAIRMAN. How do you account for the additional supply down below?

Mr. CARPENTER. It must come from the supply from the mountain, I think, indirectly. It can not come from seepage from irrigation in that immediate vicinity, I think. The water from the mountains must outcrop at various places, as we know it does at the head of the Republican River and so on through Kansas. The Republican River rises in the eastern part of the State entirely away from the mountains or any perpetual water-shed or water supply in the sense of rains or snow; yet I believe it is a perpetual stream, and they are irrigating from it.

The CHAIRMAN. Is there any irrigation done in Kansas from the Platte?

Mr. CARPENTER. Not that I know of, until you reach North Platte, although that is beyond my line of experience. I have confined my travels to this State, but the North Platte waters some portion of it. I have been told that there is none on the South Platte in Nebraska. The lowest ditch in this State that is of any size is the Ileff Ditch, taken from the Platte Valley, which heads just below Sterling. There we see a ditch that seems to be abandoned farther east.

The CHAIRMAN. In your travels this summer have you observed many places where they have attempted to store water, in reservoirs or otherwise, to increase the supply?

Mr. CARPENTER. Yes; I have seen some.

The CHAIRMAN. Describe them and their success.

Mr. CARPENTER. As to a part of them I can not describe their success. In the Arkansas Valley there is a reservoir, covering about 200 acres, about 200 miles from Lamard. It was in process of construction when I was there in April. I have here a photograph of the embankment, which is quite long. It is about 110 miles from the headgate of that canal, that being the largest canal in the State. The canal has been a success during the year, and has furnished a good deal of water. In the northern part of the State there are a number of reservoirs. As to the North Poudre the superintendent is here and can give you definite information, and I would prefer that he should give it. In many cases they have helped out wonderfully. The crops would have been a failure without them.

The CHAIRMAN. Have you heard any discussion of the amount of evaporation from the time of the storage of the water until they got ready to use it?

Mr. CARPENTER. We have conducted a series of experiments at the college, and know something approximately of the evaporation. I have a chart here showing the evaporation, if you would like to look at it.

The CHAIRMAN. We should like to see it.

Mr. CARPENTER (producing the chart). Experiments have been conducted at the college in tanks for several years. I do not know the circumstances of those that were made before I came there, but I combined the experiments of last year, September to December, with those of the first half of this year and reduced them to the evaporation day-rate. In January and February the water was frozen, but we melted it and divided the loss by the number of days. The horizontal lines on this chart represent hundredths of an inch. In January the average was .035 of an inch per day. The progress of the curve indicates the *general run*. In April it ran up to between .13 and .14 of an inch per

lay. In May we had a very rainy month, and it increased. In July it an up to between .17 and .18 of an inch, as an average, per day. We ave taken those observations twice a day with the book gauge, so that ur experiments are correct, because that is the most careful means of easuring. At least our measurements are correct within one one-housandth of a foot, and generally within one ten-thousandth. That akes the total evaporation, I believe, about 35 inches for one year. his summer we have placed tanks in canals and tanks in reservoirs. he reservoir experiments have not been carried on now for four years, ut for the limited time in which they were carried on in one reservoir he evaporation was a little over 50 per cent. more than that shown in his chart. The tanks are in earth, and their temperature is kept cool y the temperature of the surrounding earth. Heat has, of course, reat influence on evaporation. We have really only one good result, ecause of one of the tanks being tampered with. The evaporation in uly was 7½ inches in the middle of the lake, probably 80 rods from the earest shore, while in this tank, the figures of which are shown in the hart, it was a little less than 5½. We placed a tank in the river, so hat the water would be of the same temperature as the river. There he evaporation was between 3 and 4 inches less than in either the tank n the earth or the tank in the reservoir. Temperature, of course, has a controlling influence on evaporation.

The CHAIRMAN. About what time does the water remain in the reservoir before it is used for irrigation purposes? When is the end of the irrigation period?

Mr. CARPENTER. That depends upon the crops. The water is needed most in June, July, and part of August.

The CHAIRMAN. Suppose the water is used in June, July, and August. Then, you commence storing at what time?

Mr. CARPENTER. It can be stored just as soon as the ice melts so that water can run in the canals or ditches. In the contracts that are made by the various ditch companies it is generally stated that the irrigation shall be from the 1st of May until the 1st of November. But they are beginning to irrigate earlier wherever they can get water.

The CHAIRMAN. Then you would not store it more than five or six months probably?

Mr. CARPENTER. No.

The CHAIRMAN. It would not be kept stored any longer than that as an average?

Mr. CARPENTER. I should not think the average amount would be much more than 4 months.

The CHAIRMAN. And during those four months, you have part of the time the maximum of evaporation?

Mr. CARPENTER. No; the maximum of evaporations in the streams is in July.

Senator JONES. And the maximum needed for irrigation would be in June, I suppose?

Mr. CARPENTER. Yes; in the latter part of May, June, and perhaps part of July—along in those three months.

The CHAIRMAN. There would not be more than 5 or 6 inches of evaporation during the time the water would have to be retained?

Mr. CARPENTER. In the month of June and July, the evaporation under reservoir conditions would not be more than 5 inches per month for these two months, judging from my limited observation.

The CHAIRMAN. Then, the whole evaporation would not exceed a foot would it?

Mr. CARPENTER. I should think not.

Senator JONES. For what time?

Mr. CARPENTER. During the irrigation season, for the time the water would be needed.

The CHAIRMAN. What I want to get at is the loss by evaporation.

Senator JONES. For the twelve months.

Mr. CARPENTER. For the twelve months, the evaporation would vary from 35 to 60 inches. Storage might begin in the fall, in case there is a reservoir. There is no reason why the winter water should not be saved. Of course, that water would be subject to a greater evaporation than in any other case.

Senator JONES. But you will have evaporation as soon as there is water in the reservoir. If you have water there for twelve months there will be evaporation for twelve months.

Mr. CARPENTER. It is not always full, as the water will be used up for irrigation during part of the time.

Senator JONES. What is the rain-fall here per year?

Mr. CARPENTER. The rain-fall for the State at Denver is something over 15 inches. From our observations at Fort Collins the rain-fall for eight years averages 13¾ inches. There is another diagram here that shows the distribution of the rain-fall, which is fully as important as the amount of rain-fall, so far as crops are concerned. A minimum of rain-fall may do a maximum of good, if it comes when it is needed. It is a chart of the average rain-fall per month. On the rain-fall map you will observe that in June the line descends somewhat, and in July it descends somewhat. In the winter the rain-fall is of course slight. A large percentage of it comes during the months of May, June, and July.

Senator JONES. State the amount of rain-fall for each month from the chart so that it may get into the record.

Mr. CARPENTER. In January it is .80 of an inch; in February, .52 of an inch; in March, .70 of an inch; in April, 1.6 inches; in May, 2.9 inches; in June, it is 1.7 inches; in July, 1.8 inches; in August it is a trifle over 1 inch; in September it is about .94 of an inch; in October, .97 of an inch; in November, .4 of an inch; and in December .35 of an inch. I have further data here from the state engineer's report. It is a chart which was made for another purpose, but it illustrates the discharge, in cubic feet per second, of the Caché la Poudre River. The actual discharge varied from day to day, but I have evened them out. On this chart there are lines which represent the actual discharge, according to the records of the state engineer's office, but the curve has been smoothed out to show the change of the stream. The first line is the discharge of 1884. These lines indicate a thousand cubic feet per second. For 1885 you will observe that the discharge was more variable and less in amount than in 1884. In 1886, the lines indicating the discharge show that in the fall and winter it became very small. Fainter lines represent the discharge of 1887, which is still smaller. In 1888 it is still smaller. As to that year Mr. La Grange, the water commissioner, is here and can tell you as to the condition of the stream.

Senator JONES. From 1884 to 1888, there was a steady decrease in the volume of the stream?

Mr. CARPENTER. Yes.

Senator JONES. This year, it would seem, there has been a slight increase?

Mr. CARPENTER. Yes. The black line running across the chart represents the supply which the ditches would carry if they had all the

water they could carry. The needs of the ditches vary. If they all want water at the same time, 2,300 feet would supply them. Early in May a less amount would supply them, but how much, I am not able to say. So this line, as a standard, would be more exact if it were a curve, because the excess of water would be greater than this chart would show. All that water [indicating by reference to the chart] is excess, and if it could be stored it would furnish an immense volume of water, which would benefit all the country east of there.

Senator JONES. For how long a time is this 2,300 feet required in the ditches?

Mr. CARPENTER. I do not know personally.

The CHAIRMAN. Is there not a time when this water is not all required in the ditches?

Mr. CARPENTER. I do not know how that is. Mr. La Grange knows more of the matter than I do.

Senator JONES. Let us see what Mr. La Grange has to say about it.

STATEMENT OF B. S. LA GRANGE.

Senator JONES. Mr. Carpenter has just stated that 2,300 cubic feet per second is what is required by the ditches supplied by the stream he refers to (Caché la Poudre). I ask you for how long a period the ditches require that much water?

Mr. LA GRANGE. Thirty to forty days.

Senator JONES. Within the twelve months?

Mr. LA GRANGE. Yes.

Senator JONES. Only that much within a year?

Mr. LA GRANGE. Yes, for the general irrigation. We have a surplus of about 1,100 cubic feet per second, basing it on the supposition that the intake of all the canals is 2,300 and the discharge, as recorded in the cañon, would give us about 1,100 cubic feet of surplus.

Senator JONES. That is to say, the average annual flow of the stream for twelve months would be about 3,400 feet per second, and the canals require 2,300 feet?

Mr. LA GRANGE. It is more than that for the whole twelve months. I am speaking with reference to this season. We had about 1,100 feet excess during the past season of irrigation.

The CHAIRMAN. You had that much surplus water that was wasted?

Mr. LA GRANGE. Yes.

Senator JONES. During the season of irrigation, he says.

The CHAIRMAN. Not during the whole year, then?

Mr. LA GRANGE. No, I do not mean for the whole year.

Senator JONES. There were 1,100 feet of excess during the season of irrigation?

Mr. LA GRANGE. Yes.

Senator JONES. And the whole flow was in excess, during the rest of the year?

Mr. LA GRANGE. Yes.

The CHAIRMAN. All of which might be stored and cover further land?

Mr. LA GRANGE. Certainly.

STATEMENT RESUMED OF LOUIS G. CARPENTER.

Mr. CARPENTER. The number of square miles in the Caché la Poudre Valley under ditch is 393. The number under actual irrigation I have not the data for. The State engineer has that data, however.

The CHAIRMAN. Can you figure up how much this excess would add to the land to be irrigated if it were stored?

Mr. CARPENTER. You will go into that section this evening and you can get the information there.

The CHAIRMAN. Have you anything further to state?

Mr. CARPENTER. I have a map here showing the extent of the irrigation of the State, which combines, graphically, the irrigated regions. Mr. Ulrich has here present a map showing the regions themselves, which contains much valuable information.

Senator JONES. Is this map for the entire State?

Mr. CARPENTER. Yes. This shows, approximately, the land under ditch in the Platte Valley, or Water Division No. 1. That shown in Water Division No. 2 (the Arkansas Valley) is about correct. The region of the San Luis Valley is about correct as to the lands under ditch. The regions in the other portions of the State are approximate.

Senator JONES. What do the different colors on that map represent?

Mr. CARPENTER. The yellow represents the land that Professor Hayden denominated "Agricultural land." The dark color represents the region under ditch—I do not mean irrigated, but the region that has water above it, and that, if there were water in those ditches, the land could derive the benefit of it.

Senator JONES. The colors, as I understand you, on this map show the location and quantity of land in the State of Colorado that are under ditch?

Mr. CARPENTER. Approximately, yes. The information is not exact enough to show the western part of the State accurately, but it is approximate.

Senator JONES. Can you give us any idea of the amount of land in Colorado that is susceptible of irrigation if the ditches were extended?

Mr. CARPENTER. All this portion of the State east of the mountains is agricultural land, if it had water. That is in extent about 50,000 square miles.

Senator JONES. About how much of it is so situated that water can be carried to it if a water supply were to be found in the mountains?

Mr. CARPENTER. As to that I am not prepared to state exactly.

Senator JONES. Is it a very large proportion?

Mr. CARPENTER. It is a very large proportion. From this map, and from knowing the location of the ditches from Mr. Ulrich's map and determining the area by the perimenter, I compute the total extent of the lands under ditches to be 4,552 square miles.

Senator JONES. That is, the land shown by coloring on this map.

Mr. CARPENTER. Yes.

Senator JONES. Is there water enough in the ditches to irrigate that land?

Mr. CARPENTER. No.

Senator JONES. How much more would be required in the ditches to irrigate that much land?

Mr. CARPENTER. I could only make an estimate that might be very far from the truth, but I should say three or four times as much.

Senator JONES. There is no more water in the ditches than would be necessary to irrigate one-fourth or one-third of this land.

Mr. CARPENTER. That would be my estimate, though it may be very far from the truth. It is merely an opinion. You have asked me in regard to the tenure of water property. I have brought the forms of a couple of deeds used by the canal companies, that may be entered as exhibits, which you can examine at your leisure.

FORM OF AGREEMENT FOR WATER RIGHT.

The Arkansas River Land, Reservoir, and Canal Company.

This agreement, made this ——— day of ——— in the year 18—, between the Arkansas River Land, Reservoir, and Canal Company, a corporation existing under the laws of Colorado, party of the first part, and ——— ———, of the county of ———, and ——— of ———, party of the second part, witnesseth: That in consideration of the stipulations herein contained, and the payments to be made as hereinafter specified, the first party hereby agrees to sell unto the second party ——— water right — to the use of water flowing through the canal of said company, each water right representing 1.44 cubic feet of water flowing over a weir per second, subject to the following terms and conditions, to which the said party of the second part or assigns expressly agrees:

First. The said company agrees to furnish the said water to the said second party or assigns continuously during the irrigating season, except as hereinafter provided, and at no other time, unless with consent of company thereto in writing.

Second. Said water shall be used only for irrigation and domestic purposes on the following-described tract of land, to wit, ——— ———, and under no circumstances shall said water or any portion thereof be used for mining, milling, or mechanical power, or for any other purpose not directly connected with or incidental to the purposes first herein mentioned, unless with consent of company thereto in writing.

Third. The said company shall deliver said water at such point or points along the line of said canal or ditch, or from any of its reservoirs, or either or all, as it may determine to be the most practicable, and the manner of withdrawing and regulating the supply of said water from said company's canal, ditch, or reservoir shall be prescribed by said company, and shall at all times be under its control as determined and directed by the board of directors of said company. The head-gates, flumes, weirs, or other arrangements through which the water hereby sold shall be drawn off from the said company's canal, ditch, or reservoirs shall be made and placed in position by said company, but at the cost of the said second party, who shall also be liable for the expense of keeping the same in good repair and condition, and the said company may collect and enforce the payment of all sums expended for said purposes in the same manner as prescribed for collecting and enforcing assessments.

Fourth. The said first party agrees to keep and maintain said main canal or ditch and any and all of its reservoirs in good order and condition, and in case of accident to the same to repair the injury thereby occasioned as soon as practicable and expedient; and the company shall have a right to assess for the ordinary expenses of maintaining, repairing, and superintending said canal and any and all reservoirs connected therewith a sum not exceeding $12 per water right sold per annum, payable on April 1 of the year for which said assessment is made.

Fifth. The first party shall have the right of roadway on the banks of its ditch and main laterals, and the same shall never be obstructed by fence or otherwise by second party or assigns, and in case a fence is constructed by second party across said roadway he shall construct and maintain convenient gate or gates across said banks or roadways wherever such fence may be constructed by second party. It shall be the duty of the employés of said first party to close all such gates whenever they open them.

Sixth. It is hereby distinctly understood and agreed by and between the parties hereto, that in case the canal of said company shall be unable to carry and distribute a volume of water equal to its estimated capacity, either from casual or unforseen or unavoidable accident, or if the volume of water prove insufficient from drought, or from any other cause beyond the control of the company, the company shall not be liable in any way for the shortness or deficiency of supply occasioned by any of said causes. If, however, by reason of such causes, the supply of water be insufficient to furnish an amount equal to all the water rights then outstanding the said company shall have the right to distribute such water as may flow through said canal to the holders of such water rights pro rata, and for the purpose of so doing may establish and enforce such rules as it may deem necessary or expedient.

Seventh. It is hereby specifically understood and agreed that the necessary right of way upon which to construct and maintain laterals through which to conduct water from the ditch or reservoirs of first party onto lands situate and lying below or under the lands herein described shall be, and is hereby, granted for said purposes; and the right to enter upon said lands to survey and locate said laterals, and to construct and maintain the same by first party, or the owner or owners of the lower lands, is hereby granted by second party, without other or further consideration than is herein contained; and such right of way is hereby granted where the same may be located on the lands herein described. Provided, however, that such laterals shall only be built when and where it is reasonably impracticable to do otherwise, and to the least harm and injury to said second party.

In consideration whereof the said second party agrees to pay unto said first party the sum of ——— dollars, with interest payable annually, at the rate of —— per cent. per annum.

Payment has been made and received of ——— dollars, and the remaining principal, with the annually accruing interest, shall be paid at the office of the first party in Denver, Colo., in ——— payments, at the time and in the manner following, that is to say:

	Day.	Month.	Year.	Principal.	Interest.	Amount.	Remarks.
First payment.....							
Second payment....							
Third payment.....							
Fourth payment....							
Fifth payment							
Sixth payment							

And the said second party, in consideration of the premises, hereby agrees to make punctual payment of the above sums, as each of the same respectively becomes due and to regularly and seasonably pay all assessments that may hereafter be imposed by said company for the purpose aforesaid ——— ———. And it is hereby agreed and convenanted by the parties hereto, that time and punctuality are material and essential ingredients of this contract.

It is understood and agreed that in the event of a failure to make payment of either principal or interest, when the same by the terms of this contract become due, then all the deferred payments due and to become due, as agreed, shall become then due, and the said first party shall have the right, at the expiration of sixty-days, to foreclose and terminate this contract: Provided it shall first give said second party notice of its intention so to do.

It its further agreed that the irrigating season shall commence April 1 and continue to November 1 of each and every year, and that thereafter water shall be conveyed for domestic purposes whenever reasonably practicable, subject to the right of said first party to repair, enlarge, or extend said canal.

And it is further stipulated that no assignment of the premises shall be valid unless the same shall be indorsed hereon, and that no agreements, or conditions, or relations between the second party and assignee of the second party, or any other person acquiring title or interest from or through the second party, shall preclude the first party from the right to convey the premises to the second party, the assigns of the second party, and the surrender of this agreement and the payment of the unpaid portion of the purchase-money which may be due to the first party.

It is also stipulated and agreed that from and after the execution hereof, the said second party shall enter into the use and enjoyment of the water flowing through said ditch to the extent of the right above contracted to be conveyed as fully as though a final certificate for said right had been issued, but subject, nevertheless, to all the terms and conditions above set forth.

It is further expressly understood and agreed between the parties hereto, that neither this contract nor any of its terms, conditions, or provisions shall be in any manner supplemented, altered, or changed from what has been provided, or any other or further contract be made respecting the subject-matter of this contract, except that it be indorsed hereon in writing, signed by the president, and attested by the secretary, under the corporate seal of said company.

It is agreed and understood that when the owner or holder of a water right has fully paid for the same, he may have the right to relocate the same, wholly or in part, upon any other land under the line of the company's canal, provided the same be done without any detriment, expense, or liability whatever to said canal company.

It is hereby further stipulated and agreed that when said first party shall have sold, *and shall have* outstanding and in force a number of water rights equal to the estimated capacity of the company's ditch, to furnish water, and two-fifths of the contract

price for the same shall have been paid, then the holder or holders of such contracts for water rights shall have a voice and vote in the management of the affairs of said company's canal, proportioned to the interest which said second parties' contract bears to the entire number of contracts outstanding; and when two-thirds of such outstanding rights have been fully paid for, according to the terms of the several contracts entered into, then the title to said canal shall pass to the owners and holders of contracts for such water rights at the time, on the plan following:

Within sixty days thereafter, at such time as may be fixed by the board of directors of first party, said board of directors of first party shall hold a meeting for the purpose, and thereat designate ——— persons, who are at that time owners of water rights under said ditch, to be the incorporators of a new company, to be incorporated under the laws of the State of Colorado, and which said ——— persons shall, within thirty days thereafter, subscribe to articles incorporating a new stock company under a new name, and said ——— persons shall be the directors for the first year; and immediately following the signing and filing of articles of incorporation the directors thereof shall organize, make by-laws, procure a seal, and otherwise proceed as the law directs; and at said time they shall issue to the owners of said water rights, and to each owner of the capital stock of the new company, full paid, the same proportion of the whole of said stock as the water right each owner thereof has will bear to the whole amount of water rights sold as aforesaid, and second party hereby agrees to accept and receive the sock of said new company as aforesaid, and when said water rights shall have been fully paid, as aforesaid, and said ——— persons shall have been named as herein provided by first party, and said ——— persons notified in writing of that fact and that said water rights had been fully paid, as aforesaid, then the obligations of this company, said first party, in respect to said ditch and keeping the same in repair, or supplying water through the same, or any other ditch, canal, or reservoir connected therewith, shall cease, and the said new company and the stockholders thereof shall thereafter be the owners and in control of the said ditch and the water of the same.

It is expressly provided, however, that should first party, in exercising its rights in its articles of incorporation set forth, carry on any business therein named—for instance, stock-raising, farming, milling, etc., and should require water for such purposes, that first party will take the same subject to the same restrictions and rules that govern the use of water for others, and that it will also be entitled to its pro rata representation and stock in the new company.

It is further agreed that if said ——— persons provided to be appointed to incorporate a new company should decline or fail to incorporate said new company as herein contemplated, then first party may, within ——— days, appoint others for said purpose and to so continue to appoint persons until said company is incorporated as herein provided. And it is further agreed that the said first party will deliver said ditch to said water-right owners, as aforesaid, and at the time and manner aforesaid, free of any debts against the same.

In witness whereof the said Arkansas River Land, Reservoir and Canal Company has caused its corporate name to be hereunto subscribed by its president, and its corporate seal to be hereunto affixed by its secretary, as well as to a duplicate hereof, and the said ——— ——— subscribed —— name hereto, as well as to a duplicate hereof, this ——— day of ——— A. D. 188—.

Attest:

——— ———. [SEAL.]
——— ———. [SEAL.]
——— ———. [SEAL.]
——— ———. [SEAL.]
——— ———. [SEAL.]

——— ———,
Secretary.

[Indorsement:] No. —— contract. The Arkansas River Land, Reservoir and Canal Company, with ——— ———.

Received ——— 18 —, of ——— ——— the sum of ——— dollars, interest on the within contract.

Received ——— 18 — of ——— ——— the sum of ——— dollars amount of first payment on the within contract.

Similar receipts for second to sixth payments, inclusive, follow.

ASSIGNMENT.

——— ———, the within-named purchaser, for and in consideration of ——— dollars, do hereby assign and transfer all —— right, title, interest, and claim in and to the within-described right to water, unto ——— ———, of the county of ——— and ——— ———, of ———, *heirs and assigns, forever.* And —— do hereby authorize and

empower ——— ———, to receive from the said ——— ——— all unpaid balances due to said company, in part consideration for said water right, and upon the final payment of all the purchase-money, and a full compliance with all the requirements contained in the within agreement, to execute, or cause to be executed, to the said ——— ———, heirs and assigns, a deed for said water right, instead of to ———.

Given under —— hand and seal this ——— day of ———, A. D. 18—.

It is expressly understood that in consenting to recognize this assignment the officers of this company do not exempt the original purchaser from any of his liabilities under the contract, but to protect the rights of the assignee, provided he complies with his obligations.

Countersigned:

——— ———. [SEAL.]

——— ———.

——— ———.

——— of ———.

——— *County, ss:*

Before me, ——— ———, in and for said county, this day personally came ——— ———, known to me to be the identical person described in the within agreement, and who executed the foregoing assignment, and acknowledged that —— signed, sealed, and delivered the same as —— free and voluntary act and deed for the use and purposes herein set forth.

Given under my hand and seal of office this ——— day of ———, A. D. 18—.

——— ———.

FORM OF WATER DEED.

Know all men by these presents that the Arkansas River Land, Reservoir, and Canal Company (a corporation existing under the laws of the State of Colorado), of the first part, and ——— ———, of the county of ———, and State of Colorado, of the second part, for and in consideration of the sum of ——— dollars, paid by said second party, the receipt whereof is hereby acknowledged by said first party, and in consideration of the mutual covenants and agreements in this deed contained, to be performed and kept by both of said parties, and hereafter specially mentioned, the said first party hereby grants, bargains, sells, and conveys to the said second party, —— heirs and assigns ——— ——— water right; that is to say, the right to the use of water flowing through the canal of said first party, each water right representing 1.44 cubic feet of water flowing under a weir per second, subject, however, to the following reservations and conditions, to which said party of the second part expressly agrees:

First. Said company to furnish the said water to the second party or assigns continuously during the irrigating season, except as hereinafter provided, and at no other time, unless with consent of company thereto in writing.

Second. Said water shall be used only for irrigating and domestic purposes on the following described tracts of land, to wit, ——— ———.

Third. Said company expressly reserves to itself the right to distribute the water from its said canal, in accordance with such rights and priorities as are or may hereafter be established or decreed; and this deed is received by the party of the second part subject to such priorities.

Fourth. The said second party, —— heirs or assigns, shall not permit said water or any portion thereof, to be furnished as aforesaid, to run waste, but as soon as a sufficient quantity shall have been used for the purposes herein allowed, the second party, —— heirs or assigns, shall in such a manner as the first party may prescribe, notify the first party that the said water may be shut off, and shall also give the first party timely notice when the same shall be again needed for the purposes aforesaid; but in no case shall the amount of said water taken or received at any time by said second party, —— heirs or assigns, exceed the quantity first herein referred to.

Fifth. The said company shall deliver said water at such point or points along the line of said canal or ditch or from any of its reservoirs, or either or all, as it may determine to be the most practicable, and the manner of withdrawing and regulating the supply of said water from said company's canal, ditch, or reservoir, shall be prescribed by said company, and shall at all times be under its control, as determined and directed by the board of directors of said company. The head-gates, flumes, weirs or other arrangements through which the water hereby sold shall be drawn off from the company's canal, ditch, or reservoirs, shall be made and placed in position by said company, but at the cost of the said second party, who shall also be liable for the expense of keeping the same in good repair and condition, and the said company may collect and enforce the payment of all sums expended for said purpose in the same manner as prescribed for collecting and enforcing assessments.

Sixth. The said first party agrees to keep and maintain said main canal or ditch

l any and all of its reservoirs in good order and condition, and in case of accident the same to repair the injury thereby occasioned as soon as practicable and ex- lient; and the company shall have a right to assess for the ordinary expenses of intaining, repairing, and superintending said canal and any and all reservoirs con- ɔted therewith, a sum not exceeding $12 per water right sold, per annum, payable April 1 of the year for which said assessment is made.

Seventh. The said first party to have, and the said second party hereby grants to ɔ said first party, a right of way across said above-described land of the width of —— ———, of the main canal of said first party as now located, and also the right roadway on the banks of the canal and main laterals; and in case a fence is con- ucted by said second party across said roadway, he should construct and maintain gateway across said bank, when said first party finds it necessary to use said bank a roadway, in which case said first party shall close said gate when opened by it.

Eighth. It is hereby distinctly understood and agreed by and between the parties reto, that in case the canal of said company shall be unable to carry and distribute volume of water equal to its estimated capacity, either from casual or unforeseen or avoidable accident, or if the volume of water prove insufficient from drought, or ɔm any other cause beyond the control of said company, the company shall not be ble in any way for the shortness or deficiency of supply occasioned by any of said uses. If, however, by reason of such causes, the supply of water be insufficient to rnish an amount equal to all the water rights then outstanding, the said company all have the right to distribute such water as may flow through said canal to the lders of such water rights pro rata; and for the purpose of so doing may establish d enforce such rules as it may deem necessary or expedient.

Ninth. It is hereby specifically understood and agreed that the necessary right of ay upon which to construct and maintain laterals through which to conduct water ɔm the ditch or reservoirs of first party on to lands situate and lying below or un- r the lands herein described, shall be, and is, hereby, granted for said purposes; d the right to enter upon said lands to survey and locate said laterals, and to con- uct and maintain the same by first party, or the owner or owners of the lower ıds, is hereby granted by second party, without other or further consideration than herein contained; and such right of way is hereby granted where the same may be ɔated on the lands herein described. Provided, however, that such laterals shall ly be built when and where it is reasonably impracticable to do otherwise, and to e least harm and injury to said second party.

Tenth. It is further agreed that the irrigating season shall commence April 1 and ntinue to November 1 of each and every year, and that thereafter water shall be nveyed for domestic purposes whenever reasonably practicable; subject to the right said first party to repair, enlarge, or extend said canal.

Eleventh. It is also further agreed and understood that the said party of the sec- d part, as long as said second party shall remain the owner of such water right, d entitled to control its use, shall be entitled to relocate the same upon any other ıds (owned or controlled by said second party) under the line of the said com- ny's canal, to which land a water right has not already attached, providing such location can be made without detriment, expense, or the incurment of any liabil- whatever by said company; said location to be made upon a showing by said sec- d party that said second party is still the owner of said water right, and entitled to ocate the same, and upon cancellation of the prior location, such relocation to be ɔde by the company, and a record thereof kept by said company in the records of e company.

It is hereby further stipulated and agreed that when said first party shall have sold d shall have outstanding and in force a number of water rights equal to the esti- ɔted capacity of the company's ditch, to furnish water, and two-fifths of the contract ice for the same shall have been paid, then the holder or holders of such contracts for ɔter rights shall have a voice and vote in the management of the affairs of said com- ny's canal, proportioned to the interest which said second party's contract bears to e entire number of contracts outstanding; and when two-thirds of all such outstand- g rights have been fully paid for, according to the terms of the several contracts tered into, then the title to said canal shall pass to the owners and holders of con- ɔcts for such water rights at the time, on the plan following:

Within sixty days thereafter, at such time as may be fixed by the board of direct- ɔ of first party, said board of directors of first party shall hold a meeting for the rpose, and thereat designate ——— persons, who are at that time owners of water ghts under said ditch, to be the incorporators of a new company to be incorporated der the laws of the State of Colorado, and which said ——— persons shall, within irty days thereafter, subscribe to articles incorporating a new stock company under ıew name, and said ——— persons shall be the directors for the first year; and im- ɔdiately following the signing and filing of articles of incorporation the directors ereof shall organize, make by-laws, procure a seal, and otherwise proceed as the w directs; and at said time they shall issue of the capital stock of the new com-

empower ——— ———, to receive from the said ——— ——— all unpaid balances due to said company, in part consideration for said water right, and upon the final payment of all the purchase-money, and a full compliance with all the requirements contained in the within agreement, to execute, or cause to be executed, to the said ——— ———, heirs and assigns, a deed for said water right, instead of to ———.

Given under —— hand and seal this ——— day of ———, A. D. 18—.

It is expressly understood that in consenting to recognize this assignment the officers of this company do not exempt the original purchaser from any of his liabilities under the contract, but to protect the rights of the assignee, provided he complies with his obligations.

Countersigned:

——— ———. [SEAL.]

——— ———.

——— ———.

——— of ———.

——— *County, ss:*

Before me, ——— ———, in and for said county, this day personally came ——— ———, known to me to be the identical person described in the within agreement, and who executed the foregoing assignment, and acknowledged that —— signed, sealed, and delivered the same as —— free and voluntary act and deed for the use and purposes herein set forth.

Given under my hand and seal of office this ——— day of ———, A. D. 18—.

——— ———.

FORM OF WATER DEED.

Know all men by these presents that the Arkansas River Land, Reservoir, and Canal Company (a corporation existing under the laws of the State of Colorado), of the first part, and ——— ———, of the county of ———, and State of Colorado, of the second part, for and in consideration of the sum of ——— dollars, paid by said second party, the receipt whereof is hereby acknowledged by said first party, and in consideration of the mutual covenants and agreements in this deed contained, to be performed and kept by both of said parties, and hereafter specially mentioned, the said first party hereby grants, bargains, sells, and conveys to the said second party, —— heirs and assigns ——— ——— water right; that is to say, the right to the use of water flowing through the canal of said first party, each water right representing 1.44 cubic feet of water flowing under a weir per second, subject, however, to the following reservations and conditions, to which said party of the second part expressly agrees:

First. Said company to furnish the said water to the second party or assigns continuously during the irrigating season, except as hereinafter provided, and at no other time, unless with consent of company thereto in writing.

Second. Said water shall be used only for irrigating and domestic purposes on the following described tracts of land, to wit, ——— ———.

Third. Said company expressly reserves to itself the right to distribute the water from its said canal, in accordance with such rights and priorities as are or may hereafter be established or decreed; and this deed is received by the party of the second part subject to such priorities.

Fourth. The said second party, —— heirs or assigns, shall not permit said water or any portion thereof, to be furnished as aforesaid, to run waste, but as soon as a sufficient quantity shall have been used for the purposes herein allowed, the second party, —— heirs or assigns, shall in such a manner as the first party may prescribe, notify the first party that the said water may be shut off, and shall also give the first party timely notice when the same shall be again needed for the purposes aforesaid; but in no case shall the amount of said water taken or received at any time by said second party, —— heirs or assigns, exceed the quantity first herein referred to.

Fifth. The said company shall deliver said water at such point or points along the line of said canal or ditch or from any of its reservoirs, or either or all, as it may determine to be the most practicable, and the manner of withdrawing and regulating the supply of said water from said company's canal, ditch, or reservoir, shall be prescribed by said company, and shall at all times be under its control, as determined and directed by the board of directors of said company. The head-gates, flumes, weirs or other arrangements through which the water hereby sold shall be drawn off from the company's canal, ditch, or reservoirs, shall be made and placed in position by said company, but at the cost of the said second party, who shall also be liable for the expense of keeping the same in good repair and condition, and the said company may collect and enforce the payment of all sums expended for said purpose in the same manner as prescribed for collecting and enforcing assessments.

Sixth. The said first party agrees to keep and maintain said main canal or ditch

l any and all of its reservoirs in good order and condition, and in case of accident the same to repair the injury thereby occasioned as soon as practicable and ex- lient; and the company shall have a right to assess for the ordinary expenses of intaining, repairing, and superintending said canal and any and all reservoirs con- cted therewith, a sum not exceeding $12 per water right sold, per annum, payable April 1 of the year for which said assessment is made.

Seventh. The said first party to have, and the said second party hereby grants to said first party, a right of way across said above-described land of the width of —— ———, of the main canal of said first party as now located, and also the right roadway on the banks of the canal and main laterals; and in case a fence is con- ucted by said second party across said roadway, he should construct and maintain gateway across said bank, when said first party finds it necessary to use said bank a roadway, in which case said first party shall close said gate when opened by it.

Eighth. It is hereby distinctly understood and agreed by and between the parties reto, that in case the canal of said company shall be unable to carry and distribute volume of water equal to its estimated capacity, either from casual or unforeseen or avoidable accident, or if the volume of water prove insufficient from drought, or om any other cause beyond the control of said company, the company shall not be ble in any way for the shortness or deficiency of supply occasioned by any of said uses. If, however, by reason of such causes, the supply of water be insufficient to rnish an amount equal to all the water rights then outstanding, the said company all have the right to distribute such water as may flow through said canal to the lders of such water rights pro rata; and for the purpose of so doing may establish d enforce such rules as it may deem necessary or expedient.

Ninth. It is hereby specifically understood and agreed that the necessary right of ay upon which to construct and maintain laterals through which to conduct water om the ditch or reservoirs of first party on to lands situate and lying below or un- r the lands herein described, shall be, and is, hereby, granted for said purposes; d the right to enter upon said lands to survey and locate said laterals, and to con- uct and maintain the same by first party, or the owner or owners of the lower nds, is hereby granted by second party, without other or further consideration than herein contained; and such right of way is hereby granted where the same may be cated on the lands herein described. Provided, however, that such laterals shall ly be built when and where it is reasonably impracticable to do otherwise, and to e least harm and injury to said second party.

Tenth. It is further agreed that the irrigating season shall commence April 1 and ntinue to November 1 of each and every year, and that thereafter water shall be nveyed for domestic purposes whenever reasonably practicable; subject to the right said first party to repair, enlarge, or extend said canal.

Eleventh. It is also further agreed and understood that the said party of the sec- d part, as long as said second party shall remain the owner of such water right, d entitled to control its use, shall be entitled to relocate the same upon any other nds (owned or controlled by said second party) under the line of the said com- ny's canal, to which land a water right has not already attached, providing such location can be made without detriment, expense, or the incurment of any liabil- whatever by said company; said location to be made upon a showing by said sec- d party that said second party is still the owner of said water right, and entitled to locate the same, and upon cancellation of the prior location, such relocation to be de by the company, and a record thereof kept by said company in the records of e company.

It is hereby further stipulated and agreed that when said first party shall have sold d shall have outstanding and in force a number of water rights equal to the esti- ated capacity of the company's ditch, to furnish water, and two-fifths of the contract ice for the same shall have been paid, then the holder or holders of such contracts for ater rights shall have a voice and vote in the management of the affairs of said com- ny's canal, proportioned to the interest which said second party's contract bears to e entire number of contracts outstanding; and when two-thirds of all such outstand- g rights have been fully paid for, according to the terms of the several contracts tered into, then the title to said canal shall pass to the owners and holders of con- acts for such water rights at the time, on the plan following:

Within sixty days thereafter, at such time as may be fixed by the board of direct- s of first party, said board of directors of first party shall hold a meeting for the rpose, and thereat designate ——— persons, who are at that time owners of water ghts under said ditch, to be the incorporators of a new company to be incorporated der the laws of the State of Colorado, and which said ——— persons shall, within irty days thereafter, subscribe to articles incorporating a new stock company under new name, and said ——— persons shall be the directors for the first year; and im- diately following the signing and filing of articles of incorporation the directors ereof shall organize, make by-laws, procure a seal, and otherwise proceed as the w directs; and at said time they shall issue of the capital stock of the new com-

pany, full paid, to the owners of said water rights, such a proportion of the whole of said stock as the water right each owner thereof has will bear to the whole amount of water rights sold as aforesaid, and second party hereby agrees to accept and receeive the stock of said new company as aforesaid, and when said water rights shall have been fully paid, as aforesaid, and said ——— persons shall have been named as herein provided by first party, and said ——— persons notified in writing of that fact and that said water rights had been fully paid, as aforesaid, then the obligations of this company, said first party, in respect to said ditch and keeping the same in repair or supplying water through the same, or any other ditch, canal, or reservoir connected therewith, shall cease, and the said new company, and the stockholders thereof, shall therafter be the owners and in control of the said ditch and the water of the same.

Provided, however, and this grant is specially subject to the conditions following, that is to say: That inasmuch as said parties so holding water rights are forever exempted from any and all assessments that may be made upon the stockholders of the said company as it now exists, for any purpose, except that of keeping said ditch in repairs, as stated in subdivision 6, of this deed, and inasmuch as an increase of the capital stock of the company as it now exists may become necessary or an assessment of the present stockholders, in order to complete the construction of the ditch and reservoir of said company:

Now, therefore, said second party does hereby agree with said first party that this deed, and the right of said second party to vote and have a voice in the management of the company, is subject to the limitation that said second party shall not, by reason of anything in this deed contained or by reason of any relation he may bear to this company arising out of said water right, be entitled to claim, demand, or receive any part or portion of any moneys arising out of the sale of any stock of said company, should the said company find it necessary to increase its capital stock, and the said second party is to be allowed a voice and vote only as relates to the said company's affairs at the time of executing this deed, and necessary to securing to said second party the fullest enjoyment of said second party's water right.

It is expressly provided, however, that should first party, in exercising its rights in its articles of incorporations set forth, carry on any business therein named—for instance, stock raising, farming, milling, etc., and should require water for such purposes, that first party will take the same subject to the same restrictions and rules that govern the use of water for others, and that it will also be entitled to its pro rata representation and stock in the new company.

It is further agreed that if said ——— persons provided to be appointed to incorporate a new company should decline or fail to incorporate said new company as herein contemplated, then first party may, within ——— days appoint others for said purpose and so continue to appoint persons until said company is incorporated as herein provided. And it is further agreed that the said first party will deliver said ditch to said water-right owners as aforesaid, and at the time and manner aforesaid, free of any debts against the same.

In witness whereof, the said Arkansas River Land, Reservoir, and Canal Company has caused its corporate name to be hereunto subscribed by its —— president, and its corporate seal to be hereunto affixed by its secretary, this —— day of ——— A. D. 18—

Attest:

——— ——— [SEAL.]
——— ——— [SEAL.]
——— ——— [SEAL.]
——— ———
Secretary.

INDORSEMENT.] No. —— water deed. The Arkansas River Land, Reservoir, and Canal Company to ——— ———.

STATE OF COLORADO,
County of Arapahoe, ss:

I, ———, ———, a notary public in and for the county and State aforesaid, do hereby certify that ——— ———, the —— president of the Arkansas River Land, Reservoir, and Canal Company, personally known to me to be the person whose name is subscribed to the annexed deed, and to be the —— president of said company, appeared before me this day in person and acknowledged that he signed, sealed, and delivered the said instrument of writing, and affixed thereto the corporate seal of said company as his free and voluntary act as said —— president, and as the free and voluntary act of said company for the uses and purposes therein set forth.

Witness my hand and official seal this —— day of ———, A. D. 18—.

My commission expires on the —— day of ——— A. D. 18—.

——— ———,
Notary Public.

The CHAIRMAN. Are those samples of the general contracts?

Mr. CARPENTER. Yes, of the stock companies that sell water and make water contracts. The provisions of all are about the same.

The CHAIRMAN. Explain generally the relations of the land-owners to the water.

Senator JONES. That, I suppose, is what those deeds do.

The CHAIRMAN. There are others where the land-owners own the water, I suppose?

Mr. CARPENTER. The ditch managers could give more definite information, I suppose, than I could. There are two classes of companies. There is a mutual company class and one class of companies that are formed to sell water. The mutual companies generally divide the ditch into shares—each person taking a number of shares depending upon the extent of his property underneath. The amount of water he gets from the ditch depends in that case upon the number of shares he has in the ditch. They divide it according to the number of shares. In the second, or stock companies, they generally sell the water, or water-rights. "Water-rights," as a term, in this State, is generally taken to mean the supply of water necessary for 80 acres of land. In those companies they agree, if they have water, to give a definite amount of water, not exceeding a certain quantity. There are two general types of contract; first, a contract made by the company with a man to sell him a certain amount of water on certain conditions, provided he keeps up his payments. The second is a water deed, which is given to the man, in exchange for the first, when he has carried out the provisions of the first contract. These contracts represent the provisions of nearly all companies that I have been able to secure deeds of.

Senator JONES. Do farmers as a rule, who get water from those ditches, pay for the right to use the water perpetually, or year by year?

Mr. CARPENTER. In most cases they have a perpetual water-right. Under a few canals they rent water. The prices for perpetual water rights vary with the different canals. In the San Luis Valley they pay $400—that is $5 an acre for the perpetual right. In the northern part of the State the Larimer and Weld Company have a different price. In the case of the North Poudre it is $15 an acre. The North Poudre also has a charge of $1,200 for a perpetual right. Another prevailing price is $800, and another one is for $1,000. The Arkansas Valley Company charges that much. That is for a perpetual water-right, but all subject to an assessment for maintenance. The farmers are assessed for running expenses.

Very frequently in those deeds, almost always in fact, there is a provision that an assessment for maintenance shall not exceed a certain amount, say $10 for 80 acres, for ordinary assessments. Then they very frequently have a provision that in case of a very extraordinary difficulty in that ditch, or extraordinary repairs, they may be subject to a certain maximum assessment, $20 or so.

Senator JONES. Who is the judge of all that?

Mr. CARPENTER. The ditch company. But they very rarely charge an extraordinary assessment, even when they have extraordinary difficulties. But for the larger ditches that does not seem to be enough (with the present amount of irrigated land under them) to maintain the ditch. If all the land were under cultivation that would perhaps be enough. In other ditches the assessment is more, depending somewhat upon the local conditions, or the difficulties the company think they may meet.

In the case of the union ditches, they keep the ditches in repair, and

the prices are less, because generally the ditches are smaller and the expense of maintenance is less. A small ditch runs itself almost. In the small ones it is perhaps from 5 to 15 cents per acre per year for maintenance.

The CHAIRMAN. Who deals out the water?

Mr. CARPENTER. Each large ditch has a superintendent whose business it is to distribute the water.

Senator JONES. Who appoints him?

Mr. CARPENTER. The stock owners, or in the case of a mutual company, they have a meeting as every company would have, and make their own arrangements.

Senator JONES. The superintendent is an officer of the company?

Mr. CARPENTER. Yes, he is appointed by them, and he distributes the water according to the farmer's holdings in the ditch. In the smaller ditches where they have plenty of water, each man takes all the water he wants?

Mr. CARPENTER. I have some views of the boxes used for measuring water. In the two kinds of ditches there are really two kinds of devices. In the box where they divide the water pro rata they do not care about the amount of water but they want their share of the water in the ditch. Here are two types of boxes [showing photographs]. I will mark them "Division box A" and "Division box B" in the San Luis Valley. Both of those are used in other parts of the State. The second one is the division box of the Lariet Canal for dividing water.

In the case of the Division box A, there is a permanent partition just at the crest of the weir. In case each man is to have half of the water, this division board is in the middle, and the water will split, part of it going one way and part another. This was introduced in the San Luis Valley by Mr. Graves. It is also used in the northern part of the State.

The Lariet ditch has a movable board, so that a farmer may get more or less water, but he could not get more than his share, because the movable board is prevented from going beyond a certain point. If he wants a less quantity of water he can get it.

Senater JONES. He can regulate his own supply so as not to exceed what he is entitled to.

Mr. CARPENTER. It is arranged so that a man can have up to his supply, but can not exceed it. Here is another box for measuring water. It is called "Graves's Spill-box." There are three views of that here. This measures water by the statute inch. It is called a "spill" box probably because it is so arranged as that the water passes into the upper end of a long box, and the excess over 5 inches spills back. These other two views show the thing in operation when the water is running.

The CHAIRMAN. Is that regarded as an accurate measurement?

Mr. CARPENTER. The "inch" is not as a general thing a satisfactory measurement. It is convenient for the users because they can determine approximately the amount of water they are getting without going through a calculation. But the inch is not a very accurate measure, because, if a man is taking 100 inches and another man 10 inches, the first man gets more than ten times what the second man gets. Very few of the people have got to measuring by cubic feet, and when they do they measure over a weir, which is a very reliable way if properly conducted. This is derived, of course, from the miner's inch. In one place in the State they measure by "2 inch". I have been endeavoring to collect data of all kinds regarding this matter, but my *survey of* the State is incomplete.

The CHAIRMAN. Before you leave this question of measurement, let me inquire if they have invented any other mode of measuring water except by the inch.

Mr. CARPENTER. The contracts generally provide for measuring by cubic feet per second.

The CHAIRMAN. Have they any device for measuring by cubic feet per second?

Mr. CARPENTER. The plan of measuring by the weir is the most accurate of any I know of.

Senator JONES. How is that done?

Mr. CARPENTER. The weir is really a box or small flume. The water is brought to a rest as nearly as may be by a vertical board. This illustration [exhibiting a wood-cut] shows it very well. For accurate measurement by weir the water should come to almost a complete rest. The weir should then contract the area of the stream. Then it should have a free fall. The edge and sides of the weir should be perfectly sharp. The board over which the water falls should come to a sharp edge, and the oblique side should be toward the direction in which the water is falling. The depth of water in front of the weir should be at least twice as great as that on the weir.

The theoretical measurement supposes that the water comes from an infinite reservoir, or one from which, if the water passes over, it will not give any velocity. That has been experimented on very accurately, especially by the Massachusetts experiments of Mr. Francis, who has gone to a great deal of expense to experiment. The weir formula is most accurate when the weir is properly placed, without actually measuring the water into some vessel of a fixed capacity. Under proper conditions the result will be true to within, say, 3 per cent. That is what Professor Francis concludes. With ordinary ditch arrangements most of the weirs I have seen have not been placed under proper conditions for entire accuracy.

Senator JONES. You ascertain the amount that goes over the fall by measuring the fall of the ditch when the weir is open?

Mr. CARPENTER. No; the depth of the water above the weir. The depth of the water should not be measured at the weir itself, because, as the water passes over it, it curves. The water will begin to curve before it gets to the crest of the weir, so that the depth of the water above the crest of the weir should always be measured some distance above the weir. You see in the photograph here a stake made level with the crest of the weir, and the water is measured several feet above that, so as to avoid the curvature of the water.

Senator JONES. In practice, if you were going to take a measurement, as this is here [referring to the photograph] you would stop the water entirely and take the depth first?

Mr. CARPENTER. No.

Senator JONES. How would you measure it?

Mr. CARPENTER. Both from theoretical knowledge and from experiment, the quantity of water, depending on the depth, is known, and a formula is known which, knowing the depth and the length of the orifice, gives the discharge.

Senator JONES. That is based on the knowledge of the rapidity with which water runs under those conditions?

Mr. CARPENTER. Yes, and on experiments on the flow of water from theoretical conditions and the force of gravity. The co-efficient had to be determined by experiment, and that was done by Francis.

The CHAIRMAN. It is not expensive to arrange the weirs that way, is it?

Mr. CARPENTER. No. Of course it requires a fall, which is not always practical. If the country falls slowly, every inch may be worth saving. In such cases a measurement of that kind is somewhat objectionable.

The CHAIRMAN. Have you ever tried to get a formula that will determine, in measuring miners' inches, how much less in proportion you must have the size of the orifice when there is a large number of inches to be discharged, compared with the size when a smaller quantity has to be discharged?

Mr. CARPENTER. That would have to be determined by experiment.

The CHAIRMAN. I think it might be worth some experiment so as to determine that proportion with accuracy.

Mr. CARPENTER. Then it would be as troublesome to use as this one would be. That is the objection to the weir method.

STATEMENT OF J. C. ULRICH, OF FORT COLLINS.

The CHAIRMAN. What is your occupation?

Mr. ULRICH. I am superintendent of the North Poudre Land and Canal Company.

The CHAIRMAN. Will you give the committee any information you may have with regard to water supply and irrigation in your vicinity; what has been done there by you and what has been done by others?

Mr. ULRICH. Our principal work at present is developing some reservoirs which we have on the canal line up on the plains.

The CHAIRMAN. Where is it located?

Mr. ULRICH. Forty miles north of Fort Collins.

The CHAIRMAN. Please explain what you are doing.

Mr. ULRICH. There are natural depressions on the plains, and we make a cut from those natural depressions; we then put a pipe in the cut and build "fills," which will retain the water, which is afterward drawn off to irrigate the land.

Senator JONES. You have water ditches?

Mr. ULRICH. Yes.

Senator JONES. And you are providing those fills in order to store the excess of water in the irrigating ditches, not used during the irrigating season?

Mr. ULRICH. Yes.

The CHAIRMAN. You expect to fill them from the ditches?

Mr. ULRICH. Yes, when the rivers are high and the amount of water used by other ditches is small—where there is a considerable excess.

The CHAIRMAN. To what extent have you gone in that operation?

Mr. ULRICH. At present we have four reservoirs constructed, with an aggregate capacity of 175,000,000 cubic feet.

Senator JONES. Will they store all the excess of water that your ditch carries?

Mr. ULRICH. No, but we intend to make more.

Senator JONES. When you have reservoirs sufficient to store all the excess of water that you have, how much more land will your ditches be able to irrigate than they would be otherwise?

Mr. ULRICH. When our system is completed, we expect to serve *probably* seven or eight times as much as we can at present irrigate.

The CHAIRMAN. Have you a map showing this system?

Mr. ULRICH. Yes, this map shows it [exhibiting a map].

The CHAIRMAN. What is this map called?

Mr. ULRICH. This is a map of the North Poudre Land, Canal and Reservoir System. At present it is called the North Poudre Land and Canal Company's Canal.

Senator JONES. How long is the canal?

Mr. ULRICH. Twenty-five miles.

Senator JONES. What is its size?

Mr. ULRICH. Sixteen feet wide on the bottom, with an average depth of about 4 feet. It has a grade of about 2½ feet to the mile on the first 7 miles, and 4 feet on the rest of it, on the lower division. We estimate that it will carry about 300 cubic feet per second. The first 7 miles are in the mountains or foot-hills, and after getting out on the plains we strike the land which we expect to irrigate.

The reservoir on section 21 [illustrating] has an area of about 100 acres and a depth of 14 feet. The next reservoir brings two "fills" together, containing each about 35 acres, about 9 feet deep. The third contains 160 acres 26 feet deep. That is as far as we have completed the system at present. Then, below the last one I have mentioned, (south of it), is a chain of proposed reservoirs, aggregating something like 2,500 acres.

Senator JONES. When those are completed they will store all your excess of water, will they?

Mr. ULRICH. They will store more than we have any use for.

Senator JONES. What was the total cost of this ditch?

Mr. ULRICH. About $175,000.

Senator JONES. What will be the total cost of the reservoirs as you contemplate completing them?

Mr. ULRICH. It will take about $50,000 yet to complete them.

Senator JONES. So by an expenditure of $50,000 you increase seven or eight fold the capacity of a ditch that cost $175,000?

Mr. ULRICH. Yes.

Senator JONES. And therefore very much cheapens the cost of the water?

Mr. ULRICH. We would consider the ditch absolutely worthless without that, because we do not get water long enough in the season to irrigate a crop. Without the reservoirs the crop would be an absolute failure and our ditch a failure.

The CHAIRMAN. Have you experimented to ascertain or determine the seepage and evaporation in that vicinity?

Mr. ULRICH. No, we have not been able to ascertain the seepage. I have not been able to make any experiments on evaporation except in the winter time. Then I have been able to examine them, because we were not running any water there, either in or out, at that time. I found last year that No. 3 reservoir, containing 160 acres, only lowered about 9 inches during the six months of winter. I think there was no seepage at all, because the bottom of the reservoir is rock. The first reservoir lost about 1 foot. That would indicate that there was some seepage there, or at least more than in the other case. Whether there was any seepage in the third we could not determine.

The CHAIRMAN. What is the altitude of the country?

Mr. ULRICH. About 5,000 feet.

Senator JONES. How are those reservoirs constructed?

Mr. ULRICH. By dams. They are natural depressions, with a rim all around them. We usually make a cut on the side and take the water

from the reservoir, but make no excavation of the reservoir itself. We generally make a cut from the top of that rim, and in addition to that we raise and fill to a height depending on the contour of the country.

Senator JONES. These reservoirs are north of Fort Collins?

Mr. ULRICH. Yes.

The CHAIRMAN. Can you let us have this map?

Mr. ULRICH. Yes, you may have that.

The CHAIRMAN. What does the map now presented by you show?

Mr. ULRICH. This map shows all the irrigating ditches in the State that we can get any description of.

The CHAIRMAN. How is it marked?

Mr. ULRICH. It is marked "map of the State of Colorado, showing irrigating ditches." [Explaining it.] The first location represents the North Platte and its tributaries. The red lines indicate the irrigating ditches. The blue lines represent the streams from which taken. The second location represents the South Platte and its tributaries.

Senator JONES. The water-shed is not marked?

Mr. ULRICH. No, it is not marked. At present I can not give you this map, as it was prepared for the State Commissioner of Immigration, but I will have a copy sent to you.

The CHAIRMAN. I wish you would explain this map a little further.

Mr. ULRICH. The number of miles of irrigating ditch shown on this map is 5,500; that is for the whole State of Colorado.

Senator JONES. Can you state how many of those are in the valley of the South Platte or the Arkansas?

Mr. ULRICH. No.

Senator JONES. Can you ascertain that?

Mr. ULRICH. Yes, I can.

Senator JONES. When you send us the copy of the map, please indicate that.

Mr. ULRICH. Yes, I will do so.

Senator JONES. The water-shed of the Arkansas, the Platte, and the Colorado?

Mr. ULRICH. Yes.

Senator JONES. How many ditches are represented on that?

Mr. ULRICH. The total number of ditches represented here is 1,120. I have every reason to believe that there are a great number of small ditches that we have not been able to get any record of at all. I believe there must be 2,000 ditches in the State. Those that we have not got, however, are, I think, very small and insignificant. Those that I have shown here are from personal knowledge of the ditches, or from maps that I got from persons in the different localities.

STATEMENT OF J. R. BURTON, OF ABILENE, KANS.

The CHAIRMAN. What is your occupation?

Mr. BURTON. I am a lawyer. I am interested also in irrigation in Colorado.

The CHAIRMAN. State your interest.

Mr. BURTON. I am president of the Arkansas River Land, Reservoir, and Canal Company.

The CHAIRMAN. You may make such statement as you please with regard to irrigation.

Mr. BURTON. The canal of that company is 113.2 miles long. I have *a map here* which shows its course. [Produces map.]

The CHAIRMAN. What is the map you present?

Mr. BURTON. It is a map showing the territory covered by our canal.

The CHAIRMAN. How is the map marked?

Mr. BURTON. It is marked "map of canal and reservoirs of the A. R. L., R., and C. Company, Colorado."

The upper tracing shows the meanderings of the canal from where we take the water out of the Arkansas River, 2 miles above La Junta, to where it enters into Sand Creek, or to a point about 10 miles east of Lamar. The canal, for the first 17 miles, is 35 feet wide on the bottom. For the next 40 miles it is 42 feet, and for the balance 12 feet. It is 6 feet deep. At the end of the 99th mile we strike a natural reservoir.

Senator JONES. What is the grade of this canal?

Mr. BURTON. It averages 24 inches to the mile. As I say, we strike a natural reservoir at the 99th mile, covering 240 acres of ground. We banked a little on the west and south, and made the water in some places about 17 or 18 feet deep, or an average of 12 feet deep. We placed a head-gate on part of that, and extended our canal on to Sand Creek. This reservoir we have been using this summer and it holds water without any trouble whatever. It will irrigate fully 2,000 acres of ground.

The CHAIRMAN. Have you observed the evaporation and seepage of it this year?

Mr. BURTON. Generally, the seepage, so far as we could tell, has been practically nothing. It will hold water just like a basin. It will be observed that the reservoir is high up on the divide, far away from the river. Having run our canal so far we strike these natural reservoirs. Then, just west, or within 2 or 3 miles before we reach the canal (off the line of the ditch), there is a reservoir that we call the "King," covering about 1,040 acres, in which the water, without any embankments at all, can be made 42 feet deep, or an average of about 23 feet, and can easily irrigate 20,000 acres.

The CHAIRMAN. You have to make or cut a tunnel to get the water out?

Mr. BURTON. Yes. Our engineer has made the survey. We can cut under the ditch and also cover this territory here. There are about 200,000 acres of ground under this canal, and our present capacity is only about 65,000 acres. We have contemplated widening it. The cuts and fills and flumes now are all 60 feet wide. I mean by that that the grade in the flume is so sharp and the sides so high that it will float 60 feet of water with a fall of only 24 inches.

The CHAIRMAN. What amount of land do you intend to irrigate with those reservoirs when completed?

Senator JONES. Before you come to that, let me ask one question. Will these reservoirs that you speak of constructing store all the excess of water which your ditch carries?

Mr. BURTON. No.

Senator JONES. You have land enough to take all the water out of your ditches in the irrigating season, I understand?

Mr. BURTON. Yes; much more.

Senator JONES. You design increasing the capital of your ditch company to meet that demand?

Mr. BURTON. Yes.

Senator JONES. You propose in addition to that, to provide reservoirs to store water to be used during the irrigating season?

Mr. BURTON. Yes.

Senator JONES. Will you be able to store all that excess — can you find reservoirs enough for that?

Mr. BURTON. I should think not.

Senator JONES. Do you contemplate making any other reservoirs besides those two?

Mr. BURTON. Yes. About 2½ miles southwest of the reservoir that we are now using——

Senator JONES. That is the first-mentioned reservoir?

Mr. BURTON. Yes; below that there is a natural depression, where we could easily make a reservoir. We do not need it now, but we have secured the title to that land, and if we need it we can make use of it.

The CHAIRMAN. And if you have a surplus of water you can use it along down?

Mr. BURTON. Yes.

Senator JONES. What has been the total cost of your ditch, exclusive of reservoirs?

Mr. BURTON. About $300,000.

Senator JONES. What has been the cost of your reservoir?

Mr. BURTON. That cost very little because it is a part of the canal I spoke of; but as to the cost of the other reservoir, I have not yet received the estimate from the engineer.

Senator JONES. Can you not estimate it?

Mr. BURTON. No; but it will be trifling compared with the territory it will irrigate.

Senator JONES. From the amount of water that can be stored in the reservoir the cost will be trifling compared with the amount of water carried in the ditch?

Mr. BURTON. Yes. Wherever you go to a great depth, if the reservoir will hold water well, then the cost of the reservoir is trifling compared with the land it will irrigate.

The CHAIRMAN. How much land will you irrigate when you get this complete?

Mr. BURTON. Two hundred thousand acres; but of course that will take some years to develop.

Senator JONES. The present supply of water in the irrigating season will irrigate how much?

Mr. BURTON, About 65,000 acres; that is the present capacity of the ditch.

The CHAIRMAN. You say you reside in Kansas?

Mr. BURTON. Yes.

The CHAIRMAN. In the arid portion of the State?

Mr. BURTON. No; I live 100 miles west of Topeka, on the line of the Union Pacific Railroad.

The CHAIRMAN. What is the character of your company?

Mr. BURTON. Ours is a stock company. Many farmers imagined that they were in the rain belt and went down there and pre-empted ground and afterward discovered that they were not in the rain belt. We went there and sold water rights and began the construction of our canal. We derived a good deal of money from that before we began to build. The gentleman who furnished the brains of the enterprise is Mr. T. C. Henry, who is now abroad. We sell a perpetual water-right contract. The present price is $12.50. We agree in the contract to furnish water perpetually; enough to irrigate the land. We also have in that contract a provision for the assessment of not more than 15 cents an acre, and for that to keep up the expenses of the canal. When *we shall have* sold all the water and the enterprise is fully developed *it will then* belong to the farmers.

Senator JONES. Have you a prospectus of it in writing?

Mr. BURTON. It is in the contract, and you have a copy of that contract. Mr. Carpenter gave it to you. I might say that so far we have collected, in the two years that we have been running, 15 cents per acre, and it was paid without any trouble at all. We had a break in our canal this year. A portion of one of our flumes "went up," and it cost us about $5,000 to repair it. We have only 550 feet of fluming, however, in the 113 miles.

With regard to the homestead law, I believe a man should not be allowed to pre-empt more than 40 acres of land in the arid region. I believe the homestead law ought to be amended so that one person could not acquire more than 40 acres of land under its provisions in the arid region. My reasons for this position are, first, the average farmer could make more money farming 40 acres of land by irrigation, than he can a larger amount. The homesteader is a poor man, generally. He must borrow the money, at a very high rate of interest, with which to improve his land and live upon it, to provide himself with the necessary farming implements. He must go in debt for water, and wait for the harvest season for any returns from his toil and expenses. If he has 160 acres, his great desire to improve it all causes him to buy too much water, too much farming machinery—in short, it causes him to shoulder too much debt. His taxes and expenses are greater, and he is not capacitated to farm so much land, and farm it well, and the result is his harvest is no greater than it would have been had he carefully cultivated a smaller tract. Instead of getting out of debt and saving a little spare money to invest in live stock, or to help develop some other industry in his immediate locality, at the end of ten years he is above the average farmer if his quarter section is not mortgaged and a large share of his earnings does not annually go to the money-loaner.

Then, again, it is far better for the ditch company for the farmers to have small holdings of land. They are enabled to pay out on their water-rights, or to keep up the water-rentals. But a still greater reason is that if the homesteader could not secure but 40 acres of land, the opportunity for speculators to secure the land in the arid region by engaging professional homesteaders to prove up and obtain title would be greatly lessened. There are localities where ditches or reservoirs could and would be built but for the fact that speculators have obtained the land in this way. The interest of the ditch company and the land owner ought to be mutual. Where the land is held by farmers for homes, and especially where the land is cultivated, it is so, and there is but little or no friction between the owners of water and the owners of land.

I also think the law ought to be changed so as to make the cultivation of the land for a given time requisite to obtain title, rather than occupancy. Land that is cultivated in the arid region must have water. If the farm is once put into a state of cultivation, and has a water-right attachment, there is no danger but that it will be occupied, and, for ever after, be a home for somebody. But under the law as it now is, a homesteader may put upon the land a trifling building, ever so small and worthless, sleep there occasionally, but in reality live elsewhere, and in a short time have title from the Government, called a homestead, which, in reality, remains wild land. The spirit of the homestead law is violated, there is no home upon the land; it is used entirely for speculative purposes. I am not stating an exceptional case. In many localities it has been and is now the rule to obtain what is miscalled a homestead in this way.

Senator JONES. I would like you to state as to a man's ability to make a living on a 40-acre tract—a man with a family.

Mr. BURTON. A man, with an ordinary family, that will cultivate 40 acres of ground and have no more than that to cultivate (and he can cultivate practically all of that) will not only make enough to supply his family with the necessaries of life, but he will be like the Maine farmer, who will have a little surplus each year to put into the construction of a mill or manufactory, right beside his farm. In other words, he will have a little surplus left instead of a debt.

Senator JONES. He may have a surplus after making a living, but will a man on such a 40-acre farm make a living as easily and with as much certainty as a man now does on a 160-acre farm where he depends on rain-fall?

Mr. BURTON. Yes. He will make more money. I have 160 acres of land which cost me $8,000, near Abilene, Kans. I can go on any 40-acre farm, under my ditch, and make more clear money than I can on that land. That is my judgment, after having farmed my land for four years.

Senator JONES. Do you think the means of acquiring land under the present law ought to be repealed and nothing left standing except the homestead law?

Mr. BURTON. You might reduce the timber claim to 40 acres.

Senator JONES. How about the desert-land act?

Mr. BURTON. That ought to be repealed by all means. It is entirely on the wrong principle. Instead of making it a section, it ought to be the other way—it ought to be reduced. My idea is that, in the arid region, you ought to have a thickly-settled population, and every acre of land should be utilized.

Senator JONES. Is there much good, practically, resulting from the timber culture law?

Mr. BURTON. No.

The CHAIRMAN. Would you repeal all those laws except the homestead law?

Mr. BURTON. I think that is a good suggestion. I hesitated to be overradical, but I think it is a good suggestion to repeal them all.

The CHAIRMAN. What would you do with timber land?

Mr. BURTON. I have not given that much attention and am not prepared to suggest.

STATEMENT OF J. P. MAXWELL, STATE ENGINEER OF COLORADO.

The CHAIRMAN. You have, of course, given this subject of irrigation and water supply full consideration?

Mr. MAXWELL. Yes.

The CHAIRMAN. Please give the committee such information as you have with regard to those subjects.

Mr. MAXWELL. I have tabulated from the records in the State engineer's office certain matters upon which questions have been sent to the office, and I can give you the result of those tabulations, if you wish. That is, with reference to the mileage of ditches, the area of land under cultivation, and the area of land under ditches, and other points in connection therewith. This paper is a tabulated statement of the eastern slope, and for the distribution, under the irrigation laws of this *State, of* the water from the natural streams, irrigating canals, ditches, *and reservoirs.*

The State is divided by law into six irrigation divisions and sixty-eight water districts. In a general way, the first division comprises that portion of the State which is drained by the North and South Platte Rivers. The second division is that portion drained by the Arkansas, and the third that portion drained by the Rio Grande. These three divisions compose the eastern slope, or all that part of the State which drains into the Gulf of Mexico. I make that statement for the purpose of explaining more clearly the tabulated statement I have. The tabulation is simply confined to the eastern slope, because that is the only place I have the data for, to any great extent.

I have here the water districts comprised in the South Platte division, which is division No. 1, the names of the streams, the number of miles of ditches, the number of acres under ditch, and the number of acres actually irrigated.

In division No. 1—the Platte division—there are 2,067.36 miles of ditch; there are 1,126,800 acres under ditch; there are 631,036 acres actually irrigated.

In the Arkansas division, which is division No. 2, there are 943.30 miles of ditches; 440,240 acres under ditch; 116,047 acres actually irrigated.

The Rio Grande division is not complete, but I will give the totals as I have them. Miles of ditch, 1,033.68; acres under ditch, 596,097; acres actually irrigated, 250,263. The records of the office are not complete with regard to that. There are two districts that we have no records of at all, to amount to anything.

As a recapitulation of the eastern slope, I will state that in those three divisions we have, in the aggregate, 4,044 miles of ditch, 2,163,137 acres of land under ditch, and 997,346 acres actually irrigated.

The total area of the arid lands on the eastern slope is about 30,000,000 acres in this State. That is all agricultural land, practically. If it could be watered, it is magnificent land; and it can be watered if we have the facilities for doing so.

Senator JONES. There is no statement in this summary about the capacity of these ditches to water lands. You state that there are 2,000 miles of ditch in the first district that irrigate actually 631,036 acres of land, and that there are 1,126,800 acres under ditch; but there is no statement of the capacity of the ditches to water lands.

Mr. BURTON. I have a statement as to capacity; that is, with regard to division No. 1, or the South Platte division. This is for the year 1888.

The average discharge from the streams for four months in 1888, per second of time, was 1,624 cubic feet, and there were decreed to the ditches in that division 24,787 cubic feet per second of time.

The CHAIRMAN. Explain what you mean by "decreed."

Mr. MAXWELL. As a district, they have decrees made by the court, for that amount of water, under their several "appropriations." The total area cultivated is something over 631,000 acres, and I have estimated that about 68,000 acres of that was irrigated by reservoirs, and about 563,000 irrigated by ditches. The duty of water—1,624 feet—on that basis, would be 346 acres to the cubic foot per second.

The CHAIRMAN. What is about the duty of water, in that connection?

Mr. MAXWELL. That is very hard to determine. It is estimated all the way from 50 to 100 acres to the cubic foot per second. I think it overruns 100 acres in this division.

The CHAIRMAN. You think a cubic foot irrigates more than 100 acres?

Mr. MAXWELL. I think it does, on the average.

The CHAIRMAN. Will water perform a greater duty in older districts than in the new?

Mr. MAXWELL. Yes. In the older districts we use it over and over again in some cases, and as land is irrigated it requires a less amount of water. As an illustration, I will state that we have a gauging station at the base of the mountains at the Platte, so that we know the amount of water that comes out of the mountains. We have also a gauging station at Denver, and from the reports of those stations we determine the amount of water that passes Denver and the amount that is carried into the ditches between this point and the base of the mountain, where the other gauging station is, and we determine, to a certain extent, the amount of seepage we have the benefit of here. We have as much water in our gauging station here as we have at the base of the mountains, while a good portion is also taken out in the ditches between the two stations.

The CHAIRMAN. After the ground is filled with water it discharges itself into the river again?

Mr. MAXWELL. Yes.

The following is the table prepared by Mr. Maxwell:

COLORADO.

For the distribution, under the irrigation laws of this State, of the water from the natural streams to the irrigating canals, ditches, and reservoirs, the State is divided into six irrigation divisions and sixty-eight water districts.

In a general way, the first division comprises that portion of the State which is drained by the North and South Platte Rivers, the second division of that portion drained by the Arkansas River, and the third division of that portion drained by the Rio Grande.

These three divisions compose the "Eastern Slope," or all that part of the State which drains into the Gulf of Mexico.

EASTERN SLOPE.

Tabulated statement showing the number of miles of irrigating canals and ditches, the number of acres of land under such canals and ditches, and the number of acres of land actually irrigated by such canals and ditches.

[Compiled from data in the State engineer's office.]

SOUTH PLATTE DIVISION, No. 1.

No. of water district.	Name of principal stream in district.	Ditches.	Under ditches.	Actually irrigated.
		Miles.	*Acres.*	*Acres.*
1, 6	South Platte	238.00	150,000	39,719
2	....do	150.00	174,000	46,233
3	Cache le Poudre	340.75	207,360	103,895
4	Big Thompson	236.66	80,690	69,908
5	St. Vrain	225.50	92,460	86,655
6	Bowlder Creek	125.00	89,580	72,895
7	Clear Creek	240.00	98,558	66,405
8	South Platte	206.50	131,537	53,110
9	Bear Creek	50.00	6,915	3,742
23	South Platte	61.50	23,270	20,920
47	North Platte	124.00	46,980	41,080
46	....do	61.45	24,330	21,470
48	....do	8.00	800	4
	Total	2,067.36	1,126,800	631,036

Tabulated statement showing number of miles of irrigating canals and ditches, etc.—Cont'd.

ARKANSAS DIVISION, No. 2.

No. of water district.	Name of principal stream in district.	Ditches.	Under ditches.	Actually irrigated.
		Miles.	*Acres.*	*Acres.*
10	Fountaine que Bouille	53.00	32,680	18,000
11	Arkansas	46.10	39,820	34,780
12	....do	34.00	33,760	25,520
13	Grape Creek	3.00	600	540
14	Arkansas	92.50	13,694	7,265
15	St. Charles	91.50	7,314	4,543
16	Huerfano	340.00	32,129	12,547
17	Arkansas	167.50	224,640	38,700
18	Apishapa	24.00	6,700	6,000
19	Purgatoire	58.10	33,380	25,660
49, 66, 67	Various	29.70	5,490	2,492
	Total	943.30	440,240	116,047

RIO GRANDE DIVISION, No. 3 (SAN LUIS VALLEY).*

20	Rio Grande	300.00	398,140	98,515
21	Alamosa	175.00	57,711	45,093
22	Conejos	160.00	45,711	33,340
24	Culebra and Costilla	(†)	(†)	(†)
25	San Luis Creek	227.76	42,425	31,315
26	Saguache	143.80	33,380	28,000
27	La Garita	5.60	570	500
35	Trinchera	21.50	18,160	13,500
	Total	1,033.68	596,097	250,263

RECAPITULATION.

Division No. 1	2,067.36	1,126,800	631,036
Division No. 2	943.30	440,240	116,047
Division No. 3	1,033.63	596,097	250,263
Aggregate	4,044.29	2,163,137	997,346

Total area of arid land ..... acres 30,000,000

* The records relating to this division are not complete. † No data.

Division No. 1.

Average discharge of streams for four months in 1888, per second, 1,624 cubic feet, and decreed, 24,787.81 cubic feet.

	Acres.
Total area irrigated	631,000
Irrigated by reservoirs	68,000
Irrigated by ditches	563.000

Duty of water, as per above, 346 acres per second foot.

One thousand six hundred and twenty-four cubic feet per second will cover 563,000 acres with water .69 foot, or 8.28 inches deep in one hundred and twenty days.

Measurement of local flood storms.

August 1, 1888. Clear Creek discharged for two hours 8,700 cubic feet; Clear Creek decrees, 1,131 cubic feet; surplus, 6,569 cubic feet; 47,296,800 cubic feet in two hours, which would cover 1,086 acres 12 inches deep.

Coal Creek (a practically dry stream) August 10, 1889, discharged for three hours 968.40 cubic feet per second, making 10,458,720 cubic feet, which would cover 240 acres 12 inches deep. Same creek, September, 1887, discharged for two hours 6,076 cubic feet per second, making 43,747,200 cubic feet, which would cover 1,004 acres 12 inches deep.

Senator JONES. Let me ask you some questions concerning this statement. You say "duty of water, as per above, 346 acres per second foot." By that statement do you mean that 631,000 acres of land are actually irrigated, and that 346 acres are actually irrigated per second?

Mr. MAXWELL. I mean that 631,000 acres are actually irrigated and that we have 346 cubic feet per second.

Senator JONES. Can the water capacity of the first district be materially increased with that sort of showing?

Mr. MAXWELL. Yes, I think it can be increased.

Senator JONES. From the conversation of the local floods?

Mr. MAXWELL. Yes.

The CHAIRMAN. By means of their storage?

Mr. MAXWELL. From such storage.

Senator JONES. So far as the running capacity of the streams is concerned, I should think that that was exhausted by this showing, and that to increase the capacity you would have to resort to storage.

Mr. MAXWELL. Yes; unless we have better facilities for spreading the water on the land and saving it.

Senator JONES. It seems to me to indicate that the facilities for spreading the water are pretty good when a foot per second irrigates 346 acres.

Mr. MAXWELL. It also indicates that we use it over and over again.

Senator JONES, Yes; I should say it was pretty well managed.

The CHAIRMAN. That is a great economy of water.

Mr. MAXWELL. It gives about 8 inches of water over the ground.

The CHAIRMAN. This takes the water during the irrigating season alone?

Mr. MAXWELL. Yes.

The CHAIRMAN. Then, what runs outside the irrigating season practically goes to waste, and if that were conserved the irrigating area could be increased in the proportion that that bears to the volume of water used in the irrigating season?

Mr. MAXWELL. Yes.

The CHAIRMAN. Then, what runs out the irrigating season practically goes to waste, and if that were conserved the irrigating area could be increased in the proportion that that bears to the volume of water used in the irrigating season?

Mr. MAXWELL. Yes.

The CHAIRMAN. Can you give any estimate of that?

Mr. MAXWELL. No. At our gauging stations we make observations during the irrigating months. In the winter time we can not do it because it freezes up, and we can not take observations or measurements.

Senator JONES. The amount of water going down these streams must be larger for the other eight months of the year than for these four months.

Mr. MAXWELL. I think there is less water during the other eight months.

Senator JONES. In the aggregate?

Mr. MAXWELL. Yes; the water gets very low in the winter time. Much of the water also becomes ice, and that we get the benefit of in the spring.

Senator JONES. What four months are those?

Mr. MAXWELL. May, June, July, and August.

The CHAIRMAN. You will file this statement, will you?

Mr. MAXWELL. Yes, but there is something else I wish to read first. I have some figures of local floods. On August 1, 1888, Clear Creek *discharged* in two hours 8,700 cubic feet per second of time, while the

ditch will only take 1,131, thus leaving a surplus of 6,569 cubic feet per second of time. There was then 47,296,800 cubic feet of water that was in excess of the demand and which could have been stored had we had the facilities for doing it.

Senator JONES. Three times as much went to waste there at that time as was used?

Mr. MAXWELL. Yes; that amount would cover 1,086 acres 12 inches deep. At Coal Creek, August 10, 1889, there was discharged for three hours, 963.4 cubic feet per second of time. That was a local flood. That makes 10,453,720 cubic feet, which would cover 240 acres, 12 inches deep. The discharge was much greater than that, but that was the maximum for two hours. In September, 1887, on the same creek, there was a discharge of 6,076 feet per second; making 43,747,200 cubic feet, which would cover 1,004 acres 12 inches deep. We have in this country a great many local water-spouts in the small cañons near the base of the mountains. They are peculiarly subject to them and we do not get the measurement of them. They do not come into the stream above our gauging stations and, of course, we have no estimate of them at all.

The CHAIRMAN. Could such water be stored and utilized?

Mr. MAXWELL. Yes, if we had the proper facilities.

Senator JONES. As to this average discharge of streams for four months in 1888 which you say is 1,624 cubic feet per second, the water was not I suppose all used in irrigation, but a considerable part of it was lost?

Mr. MAXWELL. I presume most of it was used in irrigation. In the excessive floods, however, probably some of it passed down.

Senator JONES. In the case of those two streams you have mentioned a large proportion of that water was lost?

Mr. MAXWELL. Yes, it was lost. Those are on the dry gulches.

Senator JONES. Yes; but that suggested the idea to me that there was a considerable loss of water during the irrigating season in such streams.

Mr. MAXWELL. Yes, there is during high floods a considerable loss of water.

I also have here a statement of the reservoirs on the eastern slope, giving the divisions and the acreage where I have been able to get it from the records and the capacity of the reservoir.

In division number one there are nine districts. I will simply give the totals of those. There are seventy-five reservoirs on record with a capacity of 3,168,780,082 cubic feet of water. That would furnish water 1 foot in depth for 72,746 acres.

In division number two, there are seventy-seven reservoirs, with a total capacity of 2,069,000,706 cubic feet. That amount would water 47,495 acres of land 1 foot in depth.

In division number three there are ten reservoirs, with a capacity of 82,159,000 cubic feet, which would furnish water 1 foot in depth for 1,885 acres. Those are reservoirs actually constructed, being one hundred and sixty-two in all, with a total capacity of 5,319,939,788 cubic feet, which would furnish water 1 foot in depth for 122,129 acres.

The CHAIRMAN. Have you visited those reservoirs personally?

Mr. MAXWELL. No, not all of them; only a small proportion of them in fact.

The CHAIRMAN. What is your information as to seepage and evaporation? Do the people effect much saving of water here or do they have a good deal of difficulty?

Mr. MAXWELL. I think as a general thing they save water pretty well.

The CHAIRMAN. Are they generally able to fill the ditches that are constructed?

Mr. MAXWELL. In some cases they have been able to fill them, and in some cases they have not. It depends on the water supply and the surplus.

The CHAIRMAN. They usually fill the reservoirs from the ditches.

Mr. MAXWELL. Yes.

The CHAIRMAN. They have commenced constructing reservoirs for the purpose of storing the storm water?

Mr. MAXWELL. Not to any great extent. There are a few reservoirs constructed for that purpose, but they are small.

The CHAIRMAN. Is that practical or have you not given sufficient attention to it to know?

Mr. MAXWELL. I have not given sufficient attention to it to determine the question thoroughly, but I think it is practical.

The CHAIRMAN. What observation have you made in regard to it that makes you think it is practical?

Mr. MAXWELL. My observations are principally in connection with the office, where I have been called upon to examine localities in regard to the construction of reservoirs. The State made an appropriation for the purpose of constructing a reservoir at Cold Creek to hold the flood storms.

The CHAIRMAN. Is there anything further you wish to say?

Mr. MAXWELL. I believe not.

The following is the table of reservoirs submitted by Mr. Maxwell:

Colorado (eastern slope).—Tabulated statement of reservoirs so far as the same are of record in the office of the State engineer.

DIVISION NO. 1.

Name of reservoir.	Name of stream from which water is diverted.	Area.	Capacity.
		Acres.	*Cubic feet.*
First district:			
Dry Creek	Dry Creek	10.60	2,000,000
Byers' No. 1	West Bijou	20.30	4,275,000
Byers' No. 2	do	3.80	670,556
Byers' No. 3	do	5.00	875,700
Byers' No. 4	do	13.50	2,870,000
Byers' No. 5	do	22.50	3,932,280
Byers' No. 6	do	20.00	6,996,000
Box Elder	do	.....	.....
Snow	do	.....	800,000
Brewer	do	.....	5,000,000
Total capacity		.....	27,419,536
Second district:			
Harris	Dry Creek	.....	60,000,000
German No. 1	do	.....	1,045,000
German No. 2	do	.....	54,450,000
German No. 3	do	.....	700,000
Smith	First, Second, and Third Creeks and South Platte	.....	20,000,000
Oasis	do	.....	400,000,000
Hudson	South Platte	.....	1,800,000
Hudson No. 2	do	.....	792,000
Total capacity		.....	538,787,000
Third district:			
Mitchell	North Pine	.....	14,754,930
North Poudre Co	North Poudre	.....	174,240,000
Total capacity		.....	188,994,930
Fourth district:			
Mariano	Big Thompson	373.80	180,000,000

Colorado (eastern slope).—Tabulated statement of reservoirs, etc.—Continued.

DIVISION NO. 1—Continued.

Name of reservoir.	Name of stream from which water is diverted.	Area.	Capacity.
		Acres.	*Cubic feet.*
Fifth district:			
Highland No. 2		140.00	118,119,280
Oligarchy No. 1		75.00	47,044,800
Total capacity			165,164,080
Seventh district.			
David Peabody No. 1			80,000
David Peabody No. 2			100,000
David Peabody No. 3			100,000
David Peabody No. 4			100,000
Webster	Clear Creek		7,588,900
Kox & Reser No. 1	do		2,900,000
Kox & Reser No. 2	do		699,150
Kox & Reser No. 3	do		1,761,230
Lake Erie	do		13,077,000
Ohio Lake	do		3,900,500
Cole No. 1	Clear Creek and Seepage		1,440,000
Cole No. 2	do		1,675,000
Lake No. 1	Clear Creek		2,400,000
Lake No. 2	do		16,300,000
Lake No. 3	do		1,000,000
Swan	do		6,000,000
Cart	do		100,000
Ward No. 6	do		9,429,800
Neal	do		1,258,859
A. W. Chamberlain	do		36,950,000
Church	do		7,229,017
Total capacity			114,089,456
Eighth district:			
John Thomas	Cottonwood		280,000
Limbart	Marcy Gulch		1,000,000
Lambert	Indian Creek	30.00	36,000,000
Enlargement of Frank Mannis'	Deer Creek		2,025,000
Melvin	Cherry Creek		1,000,000
Reservoir No. 1	South Platte and Bear		980,062,942
Reservoir No. 2	Bear Creek		371,944,970
Reservoir No. 3	do		85,550,957
Reservoir No. 4	Turkey Creek		12,949,061
Reservoir No. 5	Dutch Creek		223,872,560
Interlaken No. 1	Bear Creek		2,189,280
Interlaken No. 2	do		789,525
Interlaken No. 3	do		615,502
Windsor	Dry Creek	.72	92,000
Total capacity			1,668,331,817
Nineth district.			
Ward No. 1	Clear and Beaver Creek		42,364,000
Ward No. 2	do		2,272,800
Ward No. 3	do		230,000
Ward No. 4	do		320,000
H. W. Lake A	Beaver and Turkey Creek		13,939,200
H. W. Lake B	do		3,920,400
H. W. Lake C	do		653,400
H. W. Lake D	do		1,306,800
Frederick	Bear Creek		14,472,340
W. C. Henry's	Bear and Turkey Creek		9,900,000
Bowles No. 1	do		165,000,000
Bowles No. 2*	do		19,400,000
Bowles No. 3*	do		
Total capacity			283,778,940
Twenty-third district:			
Asteroea	South Platte		2,214,323

* About 12 feet deep or about 25 acres. † Estimated.

Colorado (eastern slope).—Tabulated statement of reservoirs, etc.—Continued.

RECAPITULATION, DIVISION NO. 1.

District.	No. of Reservation.	Area.	Capacity.
		Acres.	*Cubic feet.*
First	10		27, 419, 526
Second	8		538, 787, 000
Third	5		188, 994, 950
Fourth	1		180, 000, 000
Fifth	2		165, 164, 089
Seventh	21		1, 114, 089, 456
Eighth	14		1, 688, 381, 617
Nineth	13		263, 778, 940
Twenty-third	1		2, 244, 323
Total	75		3, 168, 780, 082

NOTE—The above number of cubic feet of water would furnish 1 foot in depth for 72,746 acres.

DIVISION No. 2.

Name of reservoir.	Name of stream from which water is diverted.	Area.	Capacity.
Tenth district:		*Acres.*	*Cubic feet.*
Banning & Matthews	Cheyenne Creek		3, 500
Overland Heights Improvement Company			208, 200
Johnson No. 1	Springs		330, 000
Johnson No. 2			297, 000
Johnson No. 3			297, 000
Johnson No. 4			324, 000
Johnson No. 5			324, 000
Johnson No. 6			12, 500
Johnson No. 7			12, 500
Johnson No. 8			12, 500
Johnson No. 9			12, 500
Johnson No. 10			12, 500
Johnson No. 11			600, 000
Lake Moraine	Ruxton Creek		22, 500, 000
East Colorado Springs	Sand Creek		23, 905, 210
The Broadmoor	Cheyenne Creek		8, 233, 333
Haynes	Little Fountain and Rock Creek		8, 792, 400
Bear Lake	Bear Creek		1, 285, 200
Roberts	Bierstadt		220, 000
Cheyenne Mountain	Fountain		21, 500, 000
Wolfe			160, 535
Corbin	Fountain		106, 667
Phelps	W Monument		26, 600
Mt. Baldy	Springs		21, 560, 000
Broadmoor No. 1	Broadmoor		1, 296, 000
Broadmoor No. 2	Spring		2, 000, 000
Broadmoor No. 3	Run		200, 000
Broadmoor No. 4	do		475, 000
Fursman	Bierstadt		195, 667
Total capacity			115, 957, 733
Eleventh district.			
Cottonwood Lake	Cottonwood		6, 294, 000
Donnell No. 1	Lake Fork		9, 614, 000
Donnell No. 2	do		4, 704, 400
Total capacity			20, 613, 400
Fourteenth district:			
Hobson No. 1	Fountain		4, 696, 561
Hobson No. 2	do		1, 076, 201
Hobson No. 3	do		1, 136, 133
Hobson No. 4	do		1, 637, 189
Bessemer No. 1	Arkansas		189, 000, 000
Bessemer No. 2	do		240, 000, 000
Bessemer No. 3	do		120, 000, 000
Bessemer No. 4	do		47, 000, 000
Bessemer No. 5	do		51 840, 000
Bessemer No. 6	do		15, 840, 000
Bessemer No. 7	do		28, 800, 000

ado (eastern slope).—Tabulated statement of reservoirs, etc.—Continued.

DIVISION NO. 2—Continued.

of reservoir.	Name of stream from which water is diverted.	Area.	Capacity.
listrict—Cont'd.		*Acres.*	*Cubic feet.*
r No. 8	do		31,280,000
r No. 9	do		34,500,000
r No. 10	do		43,200,000
r No. 11	do		34,560,000
r No. 12	do		54,000,000
r No. 13	do		112,000,000
apacity			1,011,596,143
trict:			
Valley	Huerfano		87,855,600
	Apache Creek		1,667,283
	Cucharas		7,741.400
A	Cheyenne Creek		56,810
B	do		19,700
C	do		50,000
D	do		78,605
	South Veta		860,000
apacity			98,329,398
district:			
rth A	Caddoa Creek		720,000
rth B	do		540,000
d No. 1	Springs		24,349
d No. 2	do		407,109
d No. 3	do		451,592
d No. 4	do		86,352
d No. 5	do		30,817
d No. 6	do		245,566
n A	Steele's Fork		360,000
n B	do		390,000
n C	do		350,000
n D	do		5,425,000
n E	do		2,760,720
n F	do		585,000
n G	do		585,000
n H	do		262,500
n O	do		210,000
n P	do		90,000
	Arkansas		748,000,000
	do		61,000,000
apacity			822,524,005

RECAPITULATION, DIVISION No. 2.

Districts.	No. reservoirs.	Area.	Capacity.
		Acres.	*Cubic feet.*
	29		115,937,752
	3		20,613,408
	17		1,011,596,143
	8		98,329,398
	20		823,524,005
	77		2,069,000,706

ne above amount would furnish 1 foot in depth of water for 47,495 acres.

Colorado (eastern slope).—Tabulated statement of reservoirs, etc.—Continued.

DIVISION No. 3.

Name of reservoir.	Name of stream from which water is diverted.	Area.	Capacity.
Twenty-second district:		*Acres.*	*Cubic feet*
Poncha No. 1	San Antonio	60.00	6,000,000
Poncha No. 2	do	40.00	4,000,000
Poncha No. 3	do		4,000,000
Poncha No. 4	do		2,000,000
Total capacity			16,000,000
Twenty-fifth district:			
High Line	Black Cañon Creek		2,000,000
Richard Cooper			64,000,000
Total capacity			66,000,000
Twenty-sixth district:			
John O'Neil's	Jones's Spring		50,000
Twenty-seventh district:			
San Juan Gulch No. 1	San Juan Gulch Creek		13,000
San Juan Gulch No. 2	do		76,000
San Juan Gulch No. 3	do		20,000
Total capacity			109,000

RECAPITULATION. DIVISION No. 3.

Districts.	No. reservoirs.	Area.	Capacity.
		Acres.	*Cubic feet.*
Twenty-second	4		16,000,000
Twenty-fifth	2		66,000,000
Twenty-sixth	1		50,000
Twenty-seventh	3		109,000
Total	10		82,159,000

NOTE.—The above amount would furnish 1 foot in depth for 1,885 acres.

GENERAL RECAPITULATION.

Division.	No. of reservoirs.	Area.	Capacity.
		Acres.	*Cubic feet.*
First	75		3,168,780,000
Second	77		2,068,000,000
Third	10		82,159,000
Grand aggregate	162		5,319,939,000

—This total amount of water would furnish 1 foot in depth of water for 122,129 acres.

STATEMENT OF JOS. C. HELM, ASSOCIATE JUSTICE, SUPREME COURT OF COLORADO.

The CHAIRMAN. Will you please state anything that may interest the committee in regard to the irrigation laws of this State?

Mr. HELM. There are several lawyers present who undoubtedly could give the committee a better idea than I can of the statutes. I simply consented to answer any questions the committee might have to ask me with regard to our decisions. I could not go into a discussion of the statutes or express any views concerning them unless I had written an opinion on the subject. There are lawyers here who will give you all the evidence you desire on that subject.

The CHAIRMAN. We do not ask any extended evidence because it is mostly in your reports I suppose. I have been a student of your reports for many years and I must say that your court is considered the most enlightened on this subject by those who are familiar with irrigation matters.

Mr. HELM. That is a compliment that we appreciate.

The CHAIRMAN. You are governed by the principle of prior appropriation?

Mr. HELM. Yes, we adopted that doctrine. I think the supreme court of the State announced that doctrine before it was incorporated into the statutes. It was in the case of Younker against Nichols, reported in the First Colorado. The court at that time decided that it was the best common-law doctrine for this country. The decisions since, I believe, have been in harmony with that. Of course a multitude of questions have come up and I think there are a dozen decisions at least in which this subject was before the court in one way or another.

The CHAIRMAN. There is a question now with regard to appropriation which is interesting the people all over the country very much; and that is what is meant by the word "appropriation," whether you mean taking the water out of the stream or whether you mean something else?

Senator JONES. I imagine the judge might object to construing the statutes.

Mr. HELM. I would not object to that so far as to state the opinion of the court about it.

The CHAIRMAN. Have you considered the question of what is prior appropriation?

Mr. HELM. I think that in a number of decisions we have announced that to constitute a valid appropriation within the meaning of the constitution (and our constitution is in accord with our common law) there must unite two acts, the diversion and the use.

The CHAIRMAN. Use for a beneficial purpose?

Mr. HELM. Use for some beneficial purpose.

The CHAIRMAN. It has been stated here that under the court decisions a certain amount of water is "decreed" to a district. What is meant by that?

Mr. HELM. Our statutes divide the State into irrigation districts, as you know, and under the statutes the district courts, which are the highest courts of record, next to the supreme court, adjudicate what we call the priorities of right. These districts are generally arranged with reference to the natural streams, and if from the principal natural stream in a district one hundred ditches have been taken, the court proceeds in the method pointed out by statute to determine the dates at

which each of these appropriations were made when the ditches were constructed; the size of the ditches; their capacity; the degree of fall of the water. Then a decree is entered which declares these dates, declares these facts, and assigns the priorities to these ditches in accordance with the dates of the diversion.

Senator JONES. The diversion and use go together?

Mr. HELM. The diversion and use. And I might say here that under our views the use must follow the diversion within a reasonable time. These decrees assign to these ditches priorities in accordance as I have stated with the dates of the diversion, and, as I have said, the use, of course, is connected with that diversion.

Senator JONES. It must be within a reasonable time?

Mr. HELM. Within a reasonable time. The question of reasonable time goes according, of course, to circumstances. But the proposition is that if the ditch is dug with due diligence and the water is applied reasonably soon, the priority relates back to the date of the commencement of the ditch.

Senator JONES. And that is a question for the court?

Mr. HELM. That is a question, I take it, to be determined in each particular case in the absence of statute. Possibly a statute might be framed which would declare how soon use must follow diversion, but so far we have no such general statute, and the court has not laid down the proposition. It would remain a question of fact to be determined at each particular case. This decree that I spoke of also determines the quantity going to each ditch. I suppose in answer to your question, that the decree of a given district must be considered and the quantity of water assigned to each particular ditch or to all the ditches taken together in the aggregate, would constitute the quantity in use or the quantity assigned.

The CHAIRMAN. If there is not water enough, those having priority under the decree would get it first?

Mr. HELM. That is the decision.

The CHAIRMAN. Have you any officer to deal it out?

Mr. HELM. We have.

The CHAIRMAN. How do you arrive at that? To get at priority, do you let them regulate it themselves?

Mr. HELM. Mr. Nettleton can answer that question better than I can, but I think in each district there is an irrigation commissioner whose duty it is to superintend the distribution of water according to the decrees of the court.

Senator JONES. Is he an officer of the court or of the State or county?

Mr. HELM. He is not an officer of the court; I think he is appointed by the governor. The governor appoints a commissioner for each water district.

The CHAIRMAN. Have you, in your decisions, classified the different uses of water, with a view of giving a preference to one use above another?

Mr. HELM. We have not, but our constitution has. First, to domestic use; second, to irrigation; third, to mining, and then to manufacturing. I believe that is the order. Domestic use is certainly first and irrigation second.

The CHAIRMAN. You have not yet by any judicial decision determined what you understand by domestic use?

Mr. HELM. We have not; I think the question has never been fairly *presented*.

The CHAIRMAN. That is a very important question.

Mr. HELM. We have a decision which touches upon it slightly but not sufficiently for me to dwell upon.

The CHAIRMAN. It ought to be limited in some way. Of course, if a man were to insist on having a river run down for the purpose of getting a drink of water it would interfere with irrigation.

STATEMENT OF WALTER H. GRAVES.

The CHAIRMAN. Will you please state anything which may interest the committee.

Mr. GRAVES. In the first place, I desire to state that I represent a company that has invested considerable money in building canals in Colorado.

Senator JONES. What is the name of the company?

Mr. GRAVES. There are various enterprises backed by Eastern capital, they are one interest but under different names. We have altogether something over 1,000 miles of canals and we have spent nearly $4,000,000 in building them. I have promised Major Powell to send him a tabulated statement, embodying some points in connection with our maps. These maps [indicating the maps] are all that I have at present. We have canals, as I say, in different parts of the State; two large canals in the western part of the State, two large ones in the San Luis Valley on the Rio Grande River, and one in the northeastern part of the State.

There are many questions that have arisen in connection with our enterprises and schemes that are of interest. Professor Carpenter has already presented some of the questions. Many of the questions you are investigating we have had occasion to deal with. In the San Luis Valley we have 468 miles of ditch. One of our canals, known as the Rio Grande Canal, is, I think, the largest canal in operation at present in the West. We have 312 miles of ditch system. The canal at the head is 80 feet wide on the bottom, and it is contemplated that it will supply water to about 240,000 acres of land. The conditions and character of the soil of the San Luis Valley, on the Rio Grande River, in the southern part of the State, are different from other sections of Colorado. That valley has an area of 5,000 square miles, and with probably 3,000,000 acres there that could be redeemed if we had the water to do it with. We have altogether in the San Luis Valley, not embodying our canals entirely, but other canals also, probably 1,150 or 1,200 miles of canal. There are supplied by these canals about 1,500,000 acres of land.

The CHAIRMAN. That is the number of acres under the canal?

Mr. GRAVES. Yes. Our water supply is not sufficient to irrigate those lands at all times. The present year has been one of low water, and we have not been able to irrigate more than 50,000 or 60,000 acres. There is a splendid opportunity for conserving the water and increasing the area of cultivated land.

The CHAIRMAN. How?

Mr. GRAVES. The Rio Grande River carries a large amount of flood water during the summer months, but of course we are unable at that time to utilize it all, and will be unable to do so even if our canal system be extended. There are probably six weeks during the average year when there will be sufficient water to irrigate the entire valley if we could rely on it, but we can not do that. There are fine sites within the mountains adjacent to the valley for building reservoirs.

In order to redeem that entire area it is necessary to conserve the water. We are all interested in the reservoir system, because that is

the only way that the entire valley can ultimately be settled. With that area we can probably support 150,000 or 200,000 people there, but with our present irrigating facilities and water supply we will not be able to support more than 50,000 people. The soil is good.

The CHAIRMAN. What is its general altitude?

Mr. GRAVES. About 7,500 feet, but the latitude is such that it gives us a good locality for irrigation. The San Luis Valley, which, by the way, is the largest valley in the Rocky Mountain region, has a soil somewhat peculiar and different from the soil on the eastern slope of the mountains. Our soil is underlaid by a heavy stratum of drift.

We find artesian water in the San Luis Valley at a depth of 800 feet, a very full flow of water that will cut a figure sometime in the progress of irrigation; but even with this artesian water and all the water we have we will be unable to redeem the valley without storing the water.

The CHAIRMAN. Have you explored the mountains with a view to finding reservoirs?

Mr. GRAVES. Yes, and a number of them have been picked out and located by the owners of the various ditches in the locality.

The CHAIRMAN. Has the Government made any surveys there yet?

Mr. GRAVES. I think Major Powell's men have been on the east slope this summer and surveyed some.

The CHAIRMAN. Are those sites on public or private lands generally?

Mr. GRAVES. Public lands mostly up in the mountains. In some cases, however, there are ranch claims that would have to be condemned to avail of the site.

The CHAIRMAN. But they are generally on public lands, you say?

Mr. GRAVES. Yes; most of the land in the San Luis Valley is public land, but the State has some 200,000 or 250,000 acres therein. In order to induce capital to invest in this enterprise the State passed a law providing for the sale of the State land in alternate quarter sections at $1.25 per acre to any company that would build a canal large enough to supply the entire area. They require the canal company to make a contract and give a bond and supply that land. There is one feature about those large enterprises which is this: Capital is loath to go in and investigate and make the expensive examination necessary to ascertain whether these canals are feasible. There are a number of canal and other irrigating projects in the State, especially in the western and southwestern portions, that would undoubtedly be undertaken if it could be demonstrated they were feasible, but in order to demonstrate that it would require the expenditure of considerable money.

The CHAIRMAN. Then you think the Government surveys would be useful?

Mr. GRAVES. By all means, yes. It seems to me that if the information could be got and promulgated, so showing that these schemes are feasible, capital might be induced to go in and construct them. That is especially true in Grand Valley. This valley, extending from Grand Junction over to the valley of the Green, in Utah, embraces a fine section of land, but to build a canal that would reclaim the whole of the land that is irrigable therein would require much money. We have made some reconnaissances to ascertain that, and it was ascertained that the canal would cost probably $2,500,000. It is hardly probable that capital would go in and build such a canal as that without some benefit that would be commensurate with the investment. I do not believe that capital will ever go in there to build a canal unless there is some inducement—some bonus or franchise to induce them to go in.

The CHAIRMAN. They could estimate that better if the surveys were made.

Mr. GRAVES. Yes, but it is highly important that these surveys should be made by the Government.

As to the question of the duty of water, you have ascertained from the State engineer's remarks here what has been done in this vicinity. I think that, in a measure, that is misleading. In the first place it is a difficult matter to ascertain absolutely the duty of water. It varies very largely with the locality, the nature of the soil, and the nature of the crop. By the most careful experiments we have been able to make in the San Luis Valley, the duty of water will run from 80 to 100 cubic feet per second. We have there offered as a premium on the minimum use of water a plan similar to this: We sell water by the quantity. In certain cases, we sell at so much a cubic foot to a certain number of individuals and deliver it to them at a certain point. They can distribute that water as suits them, but it is to their interest to make it go as far as possible. We sell water generally by the statutory inch. It is easily measured to the consumer in that way. We advise a farmer to buy so many statutory inches less than he would probably ultimately need. If, by careful and economic distribution, he can make that water cover a certain amount of land, it is to his interest to do it. That is a much better plan than to allot a certain amount of water to a certain amount of land, because in that case the farmer will surely use it, even if thereby it is wasted. In the same fields sometimes there are places that require different amounts of water, but the question of distribution in that sense is a matter for careful observation and economy.

The CHAIRMAN. Do you sell water rights?

Mr. GRAVES. We rent it per annum and we also sell it in perpetuity. We allow a man to buy as many inches as he wants to buy. If we sell him 20 or 30 inches this year, when he has paid for them we will sell him an additional amount. Each perpetual right is followed by an assessment to keep up the canal.

The CHAIRMAN. Is there any limitation on the assessment?

Mr. GRAVES. Yes; it is limited and it is sometimes graduated, running so much for a certain number of years and so much for the years following that, and so on. The idea is this: The ditch is built by the company——

Senator JONES. When you sell a number of inches do you obligate yourself to furnish that number of inches?

Mr. GRAVES. Yes.

Senator JONES. Suppose you have not got them?

Mr. GRAVES. It is provided that if the water is in the river we shall supply it. It is contemplated that if a man buys a certain right he buys a corresponding interest in the ditch, and at a certain time stock will be given to him, so that in time the consumers will own the ditch, and by electing their own officers they will have the management. By the time that is done we expect to have the ditch in perfect operation, so that the cost of maintenance would be comparatively small. This plan [referring to a map] gives a skeleton outline of our canal system.

The country lies very level, and it is such that we carry our water east and north. We carry our laterals in section lines and quarter-section lines. In some cases our laterals follow the ridges. The canal referred to has cost about $800,000.

Senator JONES. How long is it?

Mr. GRAVES. Our total mileage under that is 212 miles.

Senator JONES. How much land is covered by that ditch?

Mr. GRAVES. Two hundred and forty thousand acres.

Senator JONES. Is there water enough in it to irrigate that amount of land?

Mr. GRAVES. There is, in the river, at times.

Senator JONES. Is the capacity of the ditch sufficient to carry it?

Mr. GRAVES. It has a theoretical capacity sufficient; yes. It was built on that basis.

The CHAIRMAN. Have you adopted the plan of having storage reservoirs along the line of the ditch?

Mr. GRAVES. No, only the little one you see there [indicating by reference to the map]. Of course, for the present, we have an ample supply in the river, but since our ditch system was built quite a number of other ditches have also been built, and some must go short unless the water is supplied by means of storage.

The CHAIRMAN. What are the opportunities of storing water in this valley?

Mr. GRAVES. Practically none in the valley.

The CHAIRMAN. It is very level there?

Mr. GRAVES. Yes. It must all be done in the adjoining mountains. In Grand Valley we have an ample supply of water. Grand River is sufficient, but the difficulty there is the very great cost of maintaining the ditch. The peculiarity of the soil is such that it has been very difficult to maintain the ditch as against the floods and water-spouts during the summer.

The CHAIRMAN. We have heard a good deal of that in Utah. How much land area is there in the Grand Valley?

Mr. GRAVES. There is a very large country there that could be redeemed. We cover, by our canal, about 40,000 acres, but there must be some 250,000 to 500,000 acres that could be redeemed.

The CHAIRMAN. In that estimate do you include any portion of Utah?

Mr. GRAVES. Yes; in that estimate I include a portion of Utah. I have here two maps that I present to the committee. One is the map of the north side of the river in the San Luis Valley, and the other is a map of the south side. The first map is entitled "Map of the Del Norte Canal and laterals." This second map is entitled "Map of the Citizens' Ditch," now called the "Monte Vista Ditch."

In addition to our canal, there are probably fifteen large ditches in the valley. Many of those are comparatively new, and some of them are not noted yet in the State engineer's office. Consequently, these estimates are designed to include them.

The CHAIRMAN. If these schemes are carried out and the water used in the valley, what effect would it have on the Rio Grande Valley?

Mr. GRAVES. It would practically exhaust it; indeed, it is doing it already. We have found that it is true that after water is distributed over a country for a number of years, nearly all the swales and dry gulches become running streams.

The CHAIRMAN. Are you aware that the citizens of Mexico feel aggrieved over your use of the water?

Mr. GRAVES. Yes, we are aware of that fact, but inasmuch as we take the water here in this country, we think we have a prior right to it.

Senator JONES. You do not think that the Mexicans have a prior right?

Mr. GRAVES. That is an international question that we have not considered.

The CHAIRMAN. They say they have had it for two hundred years and have some right in the matter.

Mr. GRAVES. After we have used it for some years in all probability it will be returned to the river. We look at it as we do at an artesian well. When a man puts an artesian well on his place, we think he has a right to it, because in one sense it is a creation of his own, and when the snow falls on our mountains and the rain falls here, we think it is our water.

Senator JONES. You have not increased the snow-fall?

Mr. GRAVES. No, sir.

The CHAIRMAN. Is there anything further that you wish to say?

Mr. GRAVES. We have spent a large amount of money in the State and we are covering a much larger area of land than there is water at all times to cover. If there is any possible way in which the water could be increased or information about it could be had, it would be a material advantage or benefit to the people who have invested the money.

Senator JONES. Is all the water in the ditches practically taken in the irrigating season?

Mr. GRAVES. No, excepting in the low-water season. Our canals have only been built a few years, and the present settlement of the country is comparatively small in proportion to the amount that will ultimately be settled. It will take a great many years to fully develop this country. We have, therefore, a surplus of water except in extreme low seasons of water.

Senator JONES. What proportion of that water is taken now?

Mr. GRAVES. Possibly from 5 to 10 per cent. is utilized—may be more; I can not say exactly.

Senator JONES. Not more than from 5 to 10 per cent.?

Mr. GRAVES. No, that is the capacity of our canals.

The CHAIRMAN. You mean the water actually taken out?

Mr. GRAVES. Yes.

Senator JONES. During the irrigating season?

Mr. GRAVES. Yes, but in low-water season this year we have hardly had enough to supply our customers. We have had to economize and utilize it in the best way possible. Any information or system promulgated by the Geological Survey, or any action taken by the Government, will be highly important to us, to the capital invested, and the people who are to use the water.

Senator JONES. About what do people pay per acre for perpetual water rights to your company?

Mr. GRAVES. We do not sell or measure it in that way. We sell it by the inch to them.

Senator JONES. Yes, but you know how much it takes to irrigate an acre.

Mr. GRAVES. It varies. I might approximate it on an average.

Senator JONES. That is what I mean.

Mr. GRAVES. They are probably paying us from $5 to $8 an acre. But there is all the difference in the world in men. One man on this piece of land—his water would cost him perhaps $10 an acre. His neighbor, by more intelligent and economic use of it, might get along for $5 on the method we have adopted. A parallel case would be the consumption of gas and coal. One man will consume more than another to supply the same house.

Senator JONES. What I wanted was the average.

Mr. GRAVES. I should say an average of $5 to $10 an acre.

Senator JONES. And the expense of keeping it up is $5 to $15 per acre, did you say?

Mr. GRAVES. No, I did not say that. We charge by the inch. In the San Luis Valley the ordinary assessment runs from 15 to 30 cents an inch. In Grand River it is $1 an inch, and that is insufficient to maintain the ditch there. The expense of keeping up the ditch varies with the capacity of the canal.

Senator JONES. What is the selling price per inch?

Mr. GRAVES. We are selling it at $8 an inch in the San Luis Valley for the first 5 miles. A man 24 miles down would pay about $12 an inch for it. We charge so much an inch and agree to carry it to a certain point. For instance, if we sell to a colony, we agree to give them so many cubic feet at a certain place, and they do what they think proper with it.

Senator JONES. But in case of a failure of the water you are discharged of your obligation to furnish it?

Mr. GRAVES. If it can be had in the river we must furnish it. If it is not in the river we are relieved of our obligation.

Form of water contract in use in Colorado—submitted by Mr. Graves to the committee:

WATER CONTRACT.

Know all men by these presents, that the ——— ——— Canal Company, a corporation existing under the laws of the State of Colorado, of the first part, and ——— ———, of the county of ——— and State of Colorado, of the second part, for and in consideration of the sum of $ —— to be paid as hereinafter specified, and in consideration of the mutual covenants and agreements in this contract contained, to be performed and kept, the said company hereby agrees to carry and convey for the use of the second part—, ——— statutory inches of water in and through the canal of said company, subject to the following terms and conditions, to which the said part—of the second part, —— heirs and assigns, hereby expressly agree:

I. The said company agrees to carry and convey the said water in its said canal for the use and benefit of the said second part—, ——, heirs or assigns, continuously during the irrigating season, except as hereinafter provided, and at no other time, unless with the consent of said company thereto in writing.

II. Said water shall be used only for irrigating and domestic purposes on the following described tract of land, and none other, to wit: ——— ——— and under no circumstances shall said water, or any portion thereof, be used for mining, milling, or mechanical power, or for any other purpose not directly connected or incident to the purposes herein specified.

III. Said company expressly reserves to itself the right to distribute the water from its said canal in accordance with such rights and priorities as are or may hereafter be established or decreed; and this contract is received by the part— of the second part subject to such priorities.

IV. The said second part—, —— heirs or assigns, shall not permit said water, nor any portion thereof carried as aforesaid, to run to waste, but as soon as a sufficient the quantity shall have been used for the purposes herein allowed and contracted for, said second part—, —— heirs or assigns, shall shut off said water and keep the same shut and turned off until the same shall be again needed for the purposes aforesaid. But in no case shall the amount of water taken or received by said second part—, —— heirs or assigns, exceed the quantity first herein referred to, and said company hereby reserves the right at any time to shut off the water herein mentioned whenever it shall find that the said part—of the second part —— wasting it or not using it in accordance with the agreements herein contained on the land above mentioned.

V. The said company shall deliver said water at such point or points along the line of said canal or ditch, or from any of its reservoirs, laterals, either or all, as it may determine to be the most practicable, and the manner of withdrawing and regulating the supply of said water from said company's ditch and reservoirs shall be prescribed by said company, and shall at all times be under its control, as determined and directed by the said company. The head-gates, flumes, weirs, or other arrangements or devices, and all measuring boxes and devices through which the water hereby contracted to be carried shall be drawn and measured from said company's ditch or reservoirs, shall be made and placed in position by the said company, but at the cost of said second part—, who shall also be liable for the expense of keeping the same in good

repair and condition; and the said company may collect and enforce the payment of all sums expended for said purposes in the same manner as prescribed for collecting and enforcing assessments.

VI. The said first party agrees to keep and maintain said main canal or ditch and any and all of its reservoirs and laterals in good order and condition, and in case of accident to the same, to repair the injury thereby occasioned, as soon as practicable and expedient; and the company shall have a right to assess the said second part— for its expenses of maintaining, repairing and operating said canal, and any and all reservoirs and laterals connected therewith, including taxes and legal assessments on said canal, a sum not exceeding ——— per statutory inch hereby contracted to be carried, per annum; and in addition thereto may, when necessary by reason of accident, assess all owners or holders of water rights, pro rata, such sums as may be necessary to repair the injuries so occasioned, ——— the amount of all assessments herein provided for shall be determined and levied by said company by resolution of its board of directors, and the company also reserves to itself the right by like resolution to establish and enforce such rules and regulations, and to provide and declare such penalties as it may deem necessary and expedient for the purpose of enforcing and collecting said assessments or any part thereof. Said assessments shall be due and payable at such time as may be fixed by the board of directors of the first party, and the second part— hereby agree—to duly pay the same, and further agree—that the failure to pay the same or any part therof within sixty days after notice of the levy of any assessment (which notice may be either personal or by registered letter addressed to the second part—at ———, Colorado) shall, at the option of the board of directors of the first party, constitute a forfeiture of all the rights of second part— as provided in paragraph XIII of this agreement.

VII. The said first party shall have, and the said second part— hereby grant —to the said first party, a right of way across said above described land of the width of ——— feet for the main canal as now located and a right of way for the laterals of said first party as now located, of the width of —— feet, and also the right of roadway on the banks of the canal and main laterals; and in case a fence is constructed by said second part—across said roadway ——shall construct and maintain a gateway across said bank, when said first party requests, in which case said first party shall close said gate when opened by it.

VIII. It is hereby distinctly understood and agreed by and between the parties hereto, that in case the first party shall be unable to carry and distribute a volume of water equal to the estimated capacity of its canal, either from casual, unforeseen, or unavoidable accidents, or from any cause beyond the control of said first party, or if the volume of water prove insufficient from drought or from any other cause beyond the control of said company, the company shall not be liable in any way for the shortness or deficiency of supply so occasioned, or any loss or damage resulting therefrom by reason of any of said causes. If, however, by reason of such causes, or any of them, the supply of water be insufficient to furnish an amount equal to all the water rights then outstanding, the said company shall have the power and the right to distribute such water as may flow through said canal to the holders of such water rights pro rata, or may alternate the same; and for the purpose of so doing may establish and enforce such rules as it may deem necessary or expedient. And the second part— for ——— and —— heirs and assigns, agree— in consideration aforesaid, to waive, and hereby do— waive, any claim for loss or damage by reason of any leakage, overflow, or breaking of said company's canals, or any of its reservoirs, lakes, or laterals, either upon the land aforesaid or any other tract belonging to the part— of the second part, provided the same is not caused by the negligence of said company.

IX. The said company agrees that when it shall have sold and have outstanding and in force a number of water rights equal to the estimated capacity of the company's canal, or sooner, at its option, it will then transfer to the holder of each water right, who shall have complied with the terms and conditions of this contract, without further consideration, such a proportion of the number of shares of the capital stock of the said ——— company as the number of water rights held by —— bears to the whole number of water rights held or outstanding in the canal of the company, or as near thereto as may be possible without making fractions of shares, and which said shares the second part— agree— to accept: *Provided, however*, that such transfer is to be made only on the express condition that the first party shall thereupon and thereafter be absolutely released from any and all obligations or liabilities arising out of the ownership, operation, management, or control of said canal, or out of any contract (including this) pertaining to the distribution of water therefrom, which said obligations shall be assumed by said holders of water rights, who shall pay all expenses incident to such transfer; which said condition the said second part—, in consideration thereof and of these presents, for —— and —— heirs and assigns do— hereby accept. Such transfer shall only be made when the canal is in good order and unencumbered.

X. It is further agreed that the irrigating season shall commence April 15th and

continue to November 1st of each and every year, and that thereafter water shall be conveyed for domestic purposes whenever reasonably practicable; subject to the right of said first party to shut off the water in order to repair or enlarge or extend said canal.

XI. The payment of the consideration heretofore specified herein shall be as follows: ——— dollars upon the ensealing and delivery of this contract, payment of which is hereby acknowledged, and the balance in ——— payments at the times and in the manner following, that is to say:

	Day.	Month.	Year.	Principal.	Interest.	Amount.	Remarks.
First deferred payment....	.....	.....	.....	.....	.....	.....	....
Second deferred payment..	.....	.....	.....	.....	.....	.....	....
Third deferred payment...	.....	.....	.....	.....	.....	.....	....
Fourth deferred payment..	.....	.....	.....	.....	.....	.....	....
Fifth deferred payment....	.....	.....	.....	.....	.....	.....	....
Sixth deferred payment....	.....	.....	.....	.....	.....	.....	....
Seventh deferred payment.	.....	.....	.....	.....	.....	.....	....
Eighth deferred payment..	.....	.....	.....	.....	.....	.....	....

Said deferred payments shall bear interest at the rate of —— per cent. per annum, payable annually, and shall bear interest after maturity at the rate of —— per cent. per annum, and the second part— in consideration of the premises hereby agree— that —— will make punctual payment of the above sums, and each of the same, together with the interest thereon as the same respectively become due; and that —— will regularly and seasonably pay all assessments that may be imposed by said company for the purposes aforesaid as above agreed.

XII. In case the second part ——, legal representatives, heirs or assigns, shall pay the several sums of money punctually, and at the times above limited, and shall strictly and literally perform all and singular the agreements and stipulations aforesaid after their true tenor and intent, then this contract shall be and operate as a contract entitling said second part— in perpetuity to the enjoyment of the right hereby granted, subject, however, to the same assessments and forfeitures for non-payment as herein provided.

XIII. And it is hereby agreed and covenanted by the parties hereto that time and punctuality are essential elements of this contract. And in case the second part— shall fail to make the payments aforesaid, and each of them, or shall fail to pay any assessment which may be levied as provided in paragraphs V and VI hereof, punctually and upon the strict terms and times above limited for the payments and assessments herein provided for, or likewise to observe, perform, and complete, all and each of said agreements and stipulations aforesaid strictly and literally, without any failure or default, then this contract, so far as it may bind the first party, shall become null and void, the water may be immediately shut off, and all rights and interests hereby created or then existing in favor of the second part,—, —— heirs or assigns, or derived from this contract shall utterly cease and determine, and all equitable and legal interest in the right hereby contracted for shall revert to and revest in said first party, without any declaration of forfeiture or any other act of said first party to be performed, and without any right of said second part—of reclamation or compensation for moneys paid or services performed, as absolutely, fully, and perfectly as if this contract had never been made: *Provided*, That said first party shall give to said second part— heirs or assigns, sixty days' notice, either personal or by mail, of the said second part—, —— heirs or assigns, being in arrears upon said payments, or any of them, or the interest thereon, which notice, if by mail, shall be sufficient, if by registered letter addressed to said second part— at ——— Colorado.

XIV. It is also stipulated and agreed that no assignment of the rights of the second part— under this contract, whether by conveyance or lease of all or part of said lands, or by operation of law, or otherwise, shall be binding on the first party, so as to require it to carry for or deliver to such assignee any of the amount of water herein contracted to be carried and delivered unless the first party shall consent thereto in writing; and provided, that no assignment whatever shall be binding as to the first party herein until the same is endorsed upon these presents and consented to in writing upon these presents by the said company: *And provided further*, That nothing herein contained shall be taken to bind the party of the first part herein to release the second part— in case of such assignment, from any liabilities to said first party under this contract. The endorsement upon these presents of the company's consent to the assignment by the party— of the second part of this contract and of —— rights hereunder will be made by said company upon request of the part— of the second part, provided all payments, assessments, and charges herein provided for *which may* have become due at or prior to the time of such request shall have been *fully paid.*

XV. It is further stipulated and agreed that nothing in the foregoing provisions as to relocation and assignment shall be taken to bind the first party to convey or deliver water in less amount than 5 statutory inches for any one tract of land.

XVI. It is also stipulated and agreed that from and after the execution hereof, the said second part— may enter into the use and enjoyment of water flowing through said canal, its reservoirs or laterals, to the extent of the rights above contracted for as fully as though fully paid for, but subject, however, to all the terms, limitations, and conditions above set forth.

In witness whereof, the ——— ——— Canal Company, party of the first part, has hereunto caused its corporate name to be subscribed by its president, and attested by its secretary, and its corporate seal to be affixed hereto as well as to a duplicate hereof, and the part— of the second part— hereunto subscribed — name— and affixed — seal— hereto, as well as to a duplicate hereof, this the — day of ——— A. D. 18—

——— ——— COMPANY.

By ——— ——— *President.*

Attested by:

——— ——— *Secretary*

——— ——— [SEAL.]

Address, ——— ———

——— ——— [SEAL.]

Address, ——— ———

ASSIGNMENT.

——— ———, the within-named purchaser, for and in consideration of ——— dollars, do hereby assign and transfer all — right, title, interest, and claim in and to the within-described rights to water unto ——— ———, of ———, county of ——— and State of ———, heirs and assigns, forever; and — do hereby authorize and empower the ——— ——— Company to receive from the said ——— ——— all unpaid balances due to said company, in part consideration for said water rights.

Given under — hand and seal this — day of ———, A. D. 18—.

It is expressly understood that in consenting to recognize this assignment the officers of this company do not exempt the original purchaser from any of his liabilities under the contract, but will protect the rights of the assignee, provided he complies with its obligations.

——— ———. [SEAL.]

Countersigned.

——— ———,
President.

——— ———,
Secretary.

STATE OF COLORADO,
County of ———, *ss:*

Before me, ——— ——— in and for said county, this day personally came ——— ———, known to me to be the identical person described in the within agreement, and who executed the foregoing assignment, and acknowledged that — signed, sealed, and delivered the same as — free and voluntary act and deed, for the uses and purposes therein set forth.

Given under my hand and — seal of office this — day of ———, A. D. 18—.

——— ———.

My commission expires ———, 18—.

Received ———, 189—, of ——— ——— the sum of ——— dollars, amount of first deferred payment, on the within contract.

——— ———.

[Receipts similar to the above for the second to the eighth payments, inclusive, follow.]

(Indorsement:) No.——. Agreement to carry — inches of water. The ——— ——— with ——— ———.

The following is another form of contract in use:

WATER CONTRACT.

Know all men by these presents, that the ——— ——— Canal Company, a corporation existing under the laws of the State of Colorado, of the first part, and ——— ———, of the county of ——— and State of Colorado, of the second part, for and in consideration of the sum of $—— to be paid as hereinafter specified, and in consideration of the mutual covenants and agreements in this contract contained, to be per-

formed and kept, the said company hereby agrees to sell unto the second party a water right for —— statutory inches of water flowing through the canal of said company, subject to the following terms and conditions, to which the said party of the second part, —— heirs and assigns, hereby expressly agree:

I. The said company agrees to furnish the said water to the said second party, —— heirs or assigns, continuously during the irrigating season, except as hereinafter provided, and at no other time, unless with the consent of said company thereto in writing.

II. Said water shall be used only for irrigating and domestic purposes on the following described tract of land, and none other, to wit: ——— ——— and under no circumstances shall said water, or any portion thereof, be used for mining, milling, or mechanical power, or for any other purpose not directly connected or incident to the purposes hereinafter specified.

III. Said company expressly reserves to itself the right to distribute the water from its said canal in accordance with such rights and priorities as are or may hereafter be established or decreed; and this deed is received by the party of the second part subject to such priorities.

IV. The said second party, —— heirs or assigns, shall not permit said water, nor any portion thereof furnished as aforesaid, to run to waste, but as soon as a sufficient quantity shall have been used for the purposes herein allowed and contracted for, the said second party, —— heirs or assigns, shall shut off said water and keep the same shut and turned off until the same shall be again needed for the purposes aforesaid. But in no case shall the amount of water taken or received by said second party, —— heirs or assigns, exceed the quantity first herein referred to, and said company hereby reserves the right at any time to shut off the water herein mentioned whenever it shall find that the said part— of the second part —— wasting it or not using it on the land above-mentioned.

V. The said company shall deliver said water at such point or points along the line of said canal or ditch, or from any of its reservoirs, laterals, either or all, as it may determine to be the most practicable, and the manner of withdrawing and regulating the supply of said water from said company's ditch and reservoirs shall be prescribed by said company, and shall at all times be under its control, as determined and directed by the said company. The head-gates, flumes, weirs, or other arrangements or devices through which the water hereby sold shall be drawn from said company's ditch or reservoirs, shall be made and placed in position by the said company, but at the cost of said second part— who shall also be liable for the expense of keeping the same in good repair and condition; and the said company may collect and enforce the payment of all sums expended for said purposes in the same manner as prescribed for collecting and enforcing assessments.

VI. The said first party agrees to keep and maintain said main canal or ditch and any and all of its reservoirs and laterals in good order and condition, and in case of accident to the same, to repair the injury thereby occasioned, as soon as practicable and expedient; and the company shall have a right to assess the said second part— for its expenses of maintaining, repairing, and operating said canal and any and all reservoirs and laterals connected therewith, including taxes and legal assessments on said canal, a sum not exceeding —— per statutory inch hereby contracted to be supplied per annum; and in addition thereto may, when necessary by reason of accident, assess all owners or holders of water rights, pro rata, such sums as may be necessary to repair the injuries so occasioned. The amount of all assessments herein provided for shall be determined and levied by said company by resolution of its board of directors, and the company also reserves to itself the right by like resolution to establish and enforce such rules and regulations, and to provide and declare such penalties as it may deem necessary and expedient for the purpose of enforcing and collecting said assessments, or any part thereof. Said assessments shall be due and payable at such time as may be fixed by the board of directors of the first party, and the second part— hereby agree— to duly pay the same, and further agree— that the failure to pay the same or any part thereof within sixty days after notice of the levy of any assessment (which notice may be either personal or by registered letter addressed to the second party at ———, Colorado) shall, at the option of the board of directors of the first party, constitute a forfeiture of all the rights of the second part— as provided in paragraph XIV of this agreement.

VII. The said first party shall have, and the said second part— hereby grant— to the said first party, a right of way across said above described land of the width of ——— for the main canal or laterals of said first party as now located, and also the right of roadway on the banks of the canal and main laterals; and in case a fence is constructed by said second part— across said roadway —— shall construct and maintain a gateway across said bank, when said first party requests, in which case said first party shall close said gate when opened by it.

VIII. It is hereby distinctly understood and agreed by and between the parties hereto, that in case the first party shall be unable to carry and distribute a volume

of water equal to the estimated capacity of its canal, either from casual, unforseen, or unavoidable accidents, or from any cause beyond the control of said first party, or if the volume of water prove insufficient from drouth or from any other cause beyond the control of said company, the company shall not be liable in any way for the shortness or deficiency of supply so occasioned, or any loss or damage resulting therefrom, by reason of any of said causes. If, however, by reason of such causes, or any of them, the supply of water be insufficient to furnish an amount equal to all the water rights then outstanding, the said company shall have the power and the right to distribute such water as may flow through said canal to the holders of such water rights pro rata, or may alternate the same; and for the purpose of so doing may establish and enforce such rules as it may deem necessary or expedient. And the second part— for ——— and —— heirs and assigns, agree—, in consideration aforesaid, to waive, and hereby do waive, any claim for loss or damage by reason of any leakage, overflow, or breaking of said company's canals, or any of its reservoirs, lakes, or laterals, either upon the land aforesaid or any other tract belonging to the part— of the second part.

IX. The said company agrees that when it shall have sold and have outstanding and in force a number of water rights equal to the estimated capacity of the company's canal, or sooner at its option, it will then transfer to the holder of each water right, who shall have complied with the terms and conditions of this contract without further consideration, such a proportion of the number of the shares of the capital stock of the said ——— ——— company as the number of water rights held by —— bears to the whole number of water rights held or outstanding in the canal of the company, or as near thereto as may be possible without making fractions of shares, and which said shares the second part — agree— to accept: *Provided however*, That such transfer is to be made only on the express condition that the first party shall thereupon and thereafter be absolutely released from any and all obligations or liabilities arising out of the ownership, operation, management, or control of said canal, or out of any contract (including this) pertaining to the distribution of water therefrom, which said obligations shall be assumed by said holders of water rights, who shall pay all expenses incident to such transfer; which said condition the said second part— in consideration thereof and of these presents, for ——— and —— heirs and assigns do— hereby accept. Such transfer shall only be made when the canal is in good order and unencumbered.

X. It is further agreed that the irrigating season shall commence April 15 and continue to November 1 of each and every year, and that thereafter water shall be conveyed for domestic purposes whenever reasonably practicable; subject to the right of said first party to shut off the water in order to repair or enlarge or extend said canal.

XI. The payment of the consideration heretofore specified herein shall be as follows: —— dollars upon the ensealing and delivery of this contract, payment of which is hereby acknowleged, and the balance in —— payments at the times and in the manner following, that is to say:

	Day.	Month.	Year.	Principal.	Interest.	Amount.	Remarks.
First deferred payment....							
Second deferred payment..							
Third deferred payment...							
Fourth deferred payment..							
Fifth deferred payment....							
Sixth deferred payment....							
Seventh deferred payment.							
Eighth deferred payment..							

Said deferred payments shall bear interest at the rate of —— per cent. per annum, payable annually, and shall bear interest after maturity at the rate of —— per cent. per annum, and the second part—, in consideration of the premises, hereby agree— that —— will make punctual payment of the above sums, and each of the same, together with the interest thereon, as the same respectively become due; and that —— will regularly and seasonably pay all assessments that may be imposed by said company, for the purposes aforesaid, as above agreed.

XII. In case the second part —— legal representatives, heirs or assigns, shall pay the several sums of money punctually, and at the times above limited, and shall strictly and literally perform all and singular —— agreements and stipulations aforesaid after their true tenor and intent, then the first party shall cause to be made and executed unto the second part —— heirs or assigns, a deed conveying the water-right above described in fee-simple; subject, however, to the same assessments and forfeitures for non-payment as herein provided.

XIII. The first party claims and reserves a strip of land of the width necessary and sufficient for the right of way of the canals of the first party, and for enlarging and repairing and superintending the same where any such canal is located upon or contiguous to the premises, hereby claiming and reserving the right of way across said lands for lateral canals where the same are or may become necessary and expedient for the purpose of conveying water from the main canals of first party to the lands below, whether such laterals are constructed by the first party, or by persons owning such lower lands; provided that the laterals aforesaid shall be constructed under the supervision of and upon such lands only as are selected by the first party.

XIV. And it is hereby agreed and covenanted by the parties hereto that time and punctuality are essential elements of this contract. And in case the second part— shall fail to make the payments aforesaid, and each of them, or shall fail to pay any assessment which may be levied, as provided in paragraphs V and VI hereof, punctually and upon the strict terms and times above limited for the payments and assessments herein provided for, or likewise to observe, perform, and complete all and each of said agreements and stipulations aforesaid strictly and literally without any failure or default, then this contract, so far as it may bind the first party, shall become null and void, the water may be immediately shut off, and all rights and interests hereby created or then existing in favor of the second part —— heirs or assigns, or derived from —— —— shall utterly cease and determine, and all equitable and legal interest in the water-right —— —— hereby contracted to be conveyed shall revert to and revest in said first party, without any declaration of forfeiture or any other act of said first party to be performed, and without any right of said second part— of reclamation or compensation for moneys paid or services performed, as absolutely, fully, and perfectly as if this contract had never been made: *Provided*, That said first party shall give to said second part—, —— heirs or assigns, sixty days' notice, either personally or by mail, of the said second part —— heirs or assigns, being in arrears upon said payments, or any of them, or the interest thereon, which notice, if by mail, shall be sufficient, if by registered letter addressed to said second part— at ——, Colorado.

And it is further stipulated that no assignment of the premises shall be valid unless the same shall be indorsed hereon, and no agreements, or conditions or relations between the said second part— and —— assigns, or any other person acquiring title or interest from or through ——, shall preclude the first party from the right to convey the premises to the second part— or —— assigns, on the surrender of this agreement and the payment of the unpaid portion of the purchase money which may be due to the first party.

XV. It is also stipulated and agreed that from and after the execution hereof, the said second part — may enter into the use and enjoyment of water flowing through said canal, its reservoirs or laterals to the extent of the right, above contracted to be conveyed, as fully as though fully paid for, but subject, however, to all the terms, limitations and conditions above set forth.

In witness whereof, the —— —— Company, party of the first part, has hereunto caused its corporate name to be subscribed by its president, and attested by its secretary and its corporate seal to be affixed hereto as well as to a duplicate hereof, and the part— of the second part —— —— subscribed —— —— name— and affixed —— seal— hereto, as well as to a duplicate hereof, this the —— day —— A. D. 18—.

—— —— COMPANY,
By —— —— *President.*

Attested by—

—— —— *Secretary.*
—— —— [SEAL.]
Address: —— ——
—— —— [SEAL.]
Address: —— ——
—— —— [SEAL.]
Address: —— ——

ASSIGNMENT.

—— ——, the within-named purchaser, for and in consideration of —— dollars, do — hereby assign and transfer all —— right, title, interest and claim in and to the within-described rights to water unto —— —— of ——, county of ——, and State of ——, heirs and assigns, forever. And —— do — hereby authorize and empower the —— —— Company, to receive from the said —— —— all unpaid balances due to said Company, in part consideration for said water rights and upon *the final payment* of all the purchase money and a full compliance of all the require-

ments contained in the within agreement, to execute, or cause to be executed, to the said ——— ——— heirs and assigns, a deed of said water rights, instead of to ———.

Given under —— hand and seal, this —— day of ———, A. D., 18—.

It is expressly understood that in consenting to recognize this assignment, the officers of this Company do not exempt the original purchaser from any of his liabilities under the contract, but will protect the rights of the assignee, provided he complies with its obligations.

——— ———, [SEAL.]

Countersigned:

——— ———,
President.

——— ———,
Secretary.

STATE OF COLORADO,
County of ———, *ss.*

Before me ——— ———, in and for said county, this day personally came ——— ———, known to me to be the identical person— described in the within agreement, and who executed the foregoing assignment, and acknowledged that —— signed, sealed, and delivered the same as —— free and voluntary act and deed, for the uses and purposes herein set forth.

Given under my hand and —— seal of office, this —— day of ———, A. D. 18—.

My commission expires ———, 18—.

——— ———.

Received ———, 189—, of ——— ——— the sum of —— dollars, amount of first deferred payment on the within contract.

——— ———.

[Receipts similar to the above for the second to the eighth payments, inclusive, follow.]

(Indorsement.) No. ——. Agreement for sale of water right. The ——— ——— with ——— ——— for —— statutory inches.

The following is another form of contract in use:

WATER CONTRACT.

THE FORT MORGAN LAND AND CANAL COMPANY.

This agreement, made this —— day of ———, in the year 18—, between the Fort Morgan Land and Canal Company, a corporation existing under the laws of the State of Colorado, as the first party, and ——— ———, of the county of Weld, and State of Colorado, as the second party, witnesseth:

I. That in consideration of and subject to the stipulations herein contained, and the payments to be made as hereinafter specified, the first party hereby agrees to sell unto the second party —— heirs or assigns, —— water right —— to the use of water, flowing through the canal of said first party; each water right to be sufficient to irrigate 80 acres of land, but not to exceed 1.40 cubic feet of water per second of time, which the first party agrees to furnish to the second party —— heirs or assigns, during the irrigating season, except as hereinafter provided, and at no other time, for domestic purposes and for irrigating the following-described land, situate in the county of Weld, and State of Colorado, viz: ——— ———.

II. Said second party ——— heirs or assigns, shall not permit said water or any portion thereof, furnished as aforesaid, to run to waste, provided, however, that owners of water rights from the said canal may temporarily, for mutual convenience for irrigating purposes only, use their water in combination upon their several lands, but never upon lands for which the first party has not sold its full quota of water, on a basis of one water right to 80 acres of land.

III. Said first party shall deliver said water at such point or points along the line of said canal, or from any of its reservoirs, either or all, as it may determine from time to time to be most practicable; and the location of all headgates, and the manner of withdrawing and regulating the supply of water from said company's canals and reservoirs, shall be prescribed by said company, and shall at all times be under its control.

IV. Said first party agrees to keep and maintain said canal and any and all of its reservoirs in good order and condition, and in case of accident to the same to repair the injury thereby occasioned as soon as practicable and expedient; and the company shall have a right to assess said second party, for the expense of maintaining, repairing and superintending said canal and any and all reservoirs connected therewith, a sum

not exceeding $10 per water right sold, per annum, and in addition thereto may, when necessary by reason of accident, assess all owners or holders of water rights pro rata such sums, not exceeding $10 in any one year for each water right, as may be necessary to repair the damages so occasioned. The amount, manner of collection, and time of payment of all assessments herein provided for shall be determined by said company; and the company also reserves to itself the right to establish and enforce such rules and regulations, and to provide and declare such penalties as are necessary and expedient for the purpose of enforcing and collecting said assessments, or any part thereof.

V. It is further expressly understood and agreed that when the first party shall have sold and have outstanding and in force water rights, fully paid up, equal to the full capacity of its canal (or sooner at its option), it will distribute pro rata the stock of said company among the holders of water rights so sold and the first party as owners of unsold water rights (if any), and the second party agrees to merge —— water right —— in this contract, and the first party, in the exercise of said option, to merge all its water rights then remaining unsold, if any, severally, into the capital stock of said company, in equitable proportions to the water right— so merged.

VI. It is hereby distinctly understood and agreed by and between the parties hereto, that in case the canal of said first party shall be unable to convey and distribute a volume of water equal to the estimated capacity, either from any accident, or from lack of supply in the South Platte River, or from any other cause beyond the control of said first party, then the first party shall not be liable for the shortness or deficiency of supply so occasioned, or any losses or damages resulting therefrom. It is further agreed that during a deficiency in the water supply of such canal, from any of the causes aforesaid, the first party shall have the right to divide the diminished supply pro rata, among the holders of water rights under said canal, and for the purpose of so doing may establish and enforce such rules and regulations as are necessary and expedient. And the second party, for —— and —— heirs and assigns agree— in consideration aforesaid to waive, and do hereby waive, any claim for loss or damage by reason of any leakage or overflow of said canal, or any of its reservoirs, lakes, or laterals, not resulting from the negligence of the first party, either upon the land aforesaid or any other tract belonging to said second party.

VII. In consideration of foregoing promises, covenants, and agreements of the said party of the first part, the second party agrees to pay unto the said first party the sum of ——— dollars with interest, payable annually, at the rate of 10 per cent. per annum. Payment has been made and received of ——— dollars, and the remaining principal, with the annually accruing interest, shall be paid at the office of the first party in Denver, Colo., in ——— payments, at the times and in the manner following, that is to say:

	Day.	Month.	Year.	Principal.	Interest.	Amount.	Remarks.
First deferred payment....	.....	.....	.....	.....	.....	.....	.....
Second deferred payment..	.....	.....	.....	.....	.....	.....	.....
Third deferred payment...	.....	.....	.....	.....	.....	.....	.....
Fourth deferred payment..	.....	.....	.....	.....	.....	.....	.....
Fifth deferred payment ...	.....	.....	.....	.....	.....	.....	.....
Sixth deferred payment....	.....	.....	.....	.....	.....	.....	.....

And the second party, in consideration of the premises, hereby agrees that —— will make punctual payments of the above sums, as each of the same respectively becomes due, and that —— will regularly and seasonably pay all assessments that may hereafter be imposed by said company for the purposes aforesaid. And when the said party of the second part or —— assigns, shall have fully paid the consideration for the water rights herein conveyed, with interest thereon according to the terms of this contract, the absolute title to said water rights, free and clear of all incumbrances, shall be thereby vested in the said party of the second part, and his assigns without any further or other deed of conveyance whatsoever.

VIII. The second party for —— heirs and assigns further agree— to pay to the first party or its assigns, on such terms and regulations as its board of trustees may from time to time prescribe and determine —— proportional part of the expenses of maintaining and repairing the general fence, constructed to inclose a large tract of land lying under said canal; and said second party for —— heirs and assigns further expressly agrees, in consideration of these presents, that —— will not permit any live stock in —— possession or under —— control to run at large within such general fence; and any violation of this agreement shall render the second party —— personal representatives or assigns, liable in damages to the first party, as trustee for the benefit of any persons and their privies in interest, who may be injured by reason of *depredations* of live stock so allowed to run at large in violation hereof.

IX. And it is hereby covenanted and agreed by the parties hereto, that time and

punctuality are material and essential elements of this contract, and that in case said party of the second part shall fail or neglect to make the payments aforesaid, and each of them, at the time and times herein stipulated, then all rights, privileges, and benefits accrued or accruing under the terms of this contract in favor of said party of the second part or —— heirs or assigns, shall utterly cease and determine after thirty days' notice of such default being given by deposit thereof in the post-office at Denver, addressed to said party of the second part at his last known post-office address, or by personal service of such notice, at the option of said party of the first part, and without any right of said party of the second part of reclamation or compensation for moneys paid or services performed, as absolutely, fully, and perfectly as if this contract had never been made; and all moneys theretofore paid by said party of the second part to said party of the first part under the provisions of this contract shall belong to, and be retained by, said party of the first part as liquidated damages for the breach hereof.

It is further expressly and distinctly agreed and understood that this contract shall not be construed or operate to convey or vest any interest whatever in the water right hereinbefore mentioned until said party of the second part shall have fully performed each and every of the covenants and agreements herein contained, for the payment of the aforesaid consideration and purchase price, and shall not be assigned until fully paid up, without the consent of the first party indorsed hereon.

In witness whereof, The Fort Morgan Land and Canal Company has hereunto caused its corporate name to be subscribed by its president and attested by its secretary and its corporate seal to be affixed, and the second party —— subscribed —— name and affixed —— seal hereto, the day and year first above written.

THE FORT MORGAN LAND AND CANAL COMPANY,

By ——— ———,
President.

Attested by:

———— ————,
Secretary.

———— ———— [SEAL.]
———— ———— [SEAL.]
———— ———— [SEAL.]

ASSIGNMENT.

———— ————, the within named purchaser, for and in consideration of ——— dollars, do— hereby assign and transfer all —— right, title, interest, and claim in and to the within described rights to water unto ——— ———, of ———, county of ——— and State of ———, heirs and assigns forever. And —— do— hereby authorize and empower The Fort Morgan Land and Canal Company to receive from the said ——— ——— all unpaid balances due to said company, in part consideration for said water rights, and upon the final payment of all the purchase money, and a full compliance with all the requirements contained in the within agreement, to execute, or cause to be executed, to the said ——— ———, heirs and assigns, a deed of said water rights, instead of to ——— ———.

Given under —— hand— and seal— this —— day of ———, A. D. 18—.

It is expressly understood that in consenting to recognize this assignment, the officers of this company do not intend to exempt the original purchaser from any of his liabilities under the contract, but to protect the rights of the assignee, provided he complies with its obligations.

———— ————. [SEAL.]

Countersigned:

———— ————,
President.

———— ————,
Secretary.

STATE OF COLORADO,
County of ———, *ss:*

Before me, ——— ———, in and for said county, this day personally came ——— ———, known to me to be the identical person— described in the within agreement, and who executed the foregoing assignment, and acknowledged that —— signed, sealed, and delivered the same as —— free and voluntary act and deed for the use and purposes herein set forth.

Given under my hand and —— seal of office this —— day of ———, A. D. 18—.

———— ————.

Received ——— 18 —, of ——— ———, the sum of ——— dollars, amount of first deferred payment on the within contract.

———— ————.

[Receipts similar to the above for the second to the sixth, inclusive, follow.]

(Indorsement:) No. ——— Agreement for sale of water right. The Fort Morgan Land and Canal Company *with* ——— ———.

STATEMENT OF THOMAS P. DUNBAR.

The CHAIRMAN. I understand you have given some attention to rating lands with a view of making loans—irrigated lands and non-irrigated lands.

Mr. DUNBAR. Yes; I have been loaning money for twelve years here.

The CHAIRMAN. State your observation and experience and the rules you have been guided by in the matter of security.

Mr. DUNBAR. As a rule, I do very little in non-irrigated lands because we think them of very little value. Very few crops can be grown on them with any certainty on what we call dry lands. I confine my loans almost exclusively to lands under ditches and with ditch rights attached.

The CHAIRMAN. What are irrigated lands generally worth that are under cultivation—what would be their average value?

Mr. DUNBAR. Pure agricultural lands?

The CHAIRMAN. That is what I mean.

Mr. DUNBAR. In the best counties, Larimer and Weld, land that is well improved and well down in grasses, under a ditch that is reliable and with perpetual water-right attached to the land, go as high as from $50 to $75 an acre, the very choicest; the second class from $25 to $50.

The CHAIRMAN. That is for loaning purposes?

Mr. DUNBAR. I value them at that. They could be sold and they do sell for that. Taking the new places, like the San Luis Valley, with perpetual water-right attached to the land, the advances on loans on mortgage average from $3 to $5 per acre. The highest advances made in the State will probably range at $25 per acre. The medium advances, about $10.

The CHAIRMAN. What is the difference in the San Luis Valley between irrigated and non-irrigated lands?

Mr. DUNBAR. The lands that can not be irrigated in the San Luis Valley are only good for grazing and are not worth over $1.25 an acre. Lands under one of those ditches without a perpetual water-right to enable the acquiring owner to get water would be worth from $5 to $6 an acre.

The CHAIRMAN. If it is under cultivation, what is it worth then?

Mr. DUNBAR. That depends upon the cultivation. The trouble is with a man living on 160 acres of land, carrying a mortgage on the whole and only cultivating 25 or 50 acres. The holdings are too large. We want smaller holdings of land and better use of what we have. There should be close tillage, so as to make every gallon of water tell on every square yard of ground. They can not do it now. A man could well support and bring up his family on 40 acres if thoroughly well tilled, where he could do the work himself. He attempts to grab 320. The consequence is he has only got 10 per cent. of his land producing anything, or, if he does attempt to cultivate it, he has to do so by expensive and inefficient labor. He goes to an expense for machinery and gets no result. Instead of plowing 10 inches deep, he plows 3 inches deep and goes over a large area.

The CHAIRMAN. You think 40 acres enough for a man?

Mr. DUNBAR. Forty acres is enough for a man to live on with his family. Of course, he can not do that by raising wheat and oats.

The CHAIRMAN. He must have a variety.

Mr. DUNBAR. Yes, and a better class of crops. He should have fruit, vegetables, hops, and so on. There is a large demand for hops. I know a man making $300 or $400 an acre on hops, and a man can easily make $100 an acre on alfalfa. To get the best results a man must have a small area and cultivate closely and have a supply of farm-yard manure. Our soil here is very heavily charged with mineral matter and is very deficient in manure material. He must grow a variety of crops. We do not want men to raise a large surplus, but we want large communities and to have the land more closely cultivated, so as to bring our population nearer together, and have them produce everything that men can and need to live upon. That is what brings wealth into any State. All our immigration comes from non-irrigated districts. Everything here is new to such immigrants. The conviction is forced on my mind that a man is better off with 40 acres thoroughly cultivated than 160 acres half cultivated. You can not convince the immigrant of it, however.

The CHAIRMAN. Experience does it after awhile?

Mr. DUNBAR. Yes; but it takes a good while to convince a man sometimes.

The CHAIRMAN. As to supporting a family, which is the better situated, the man with 40 acres in the arid belt or a man with 160 acres where he has to depend upon rain-fall?

Mr. DUNBAR. If I had to bring up my family that way, I should take the 40 acres in the arid belt with irrigation.

The CHAIRMAN. You would be better off, you think?

Mr. DUNBAR. I should consider myself so.

The CHAIRMAN. What is your observation and experience?

Mr. DUNBAR. My observation is that a man is better off with 40 acres in the arid belt with every foot of it well cultivated, and his crop thoroughly attended to, than he is to have 160 acres skimped over. The man with 40 acres in the arid belt, well cultivated, will make more clear money in the end. I will lend him 25 per cent. more money on 40 acres of well cultivated land than on 160 acres half cultivated. The men that have a section of land have to have machinery and all that. Then a man's water-right will go farther on a small farm. His supply of water would have to be all put on at the same time. One great thing is to protect the land from the rays of the sun to prevent baking. You can not do that with a very large farm. I have often gone into an alfalfa field where the alfalfa grows half an inch a day in the warm weather, and within two or three weeks after it had been irrigated the crop was up 6 inches, which would prevent the land from being dried up. I have picked up there as damp a piece of soil as was wanted. On the other hand, I have been in a wet field that had been irrigated a few days before, when there was nothing to protect it from the rays of the sun and the soil was baked hard.

STATEMENT OF J. S. STANGER, OF DENVER.

The CHAIRMAN. How long have you resided in Colorado?

Mr. STANGER. Fifteen years.

The CHAIRMAN. Have you had any experience in the matter of irrigation?

Mr. STANGER. Yes; I have had theoretical experience for about twelve years. I was the editor and proprietor of the Colorado Farmer, and had some little theoretical experience in formulating the laws relating to irrigation and in *passing* them. For the last few years I have also

had practical experience as an irrigator myself. I have been farming my own land and using and distributing water on it myself many times, not only with hired help but personally.

The CHAIRMAN. State anything that will enlighten the committee in regard to it. Give us your idea of the practical work, how to distribute the water and the crops you can produce, the size of the farm you can cultivate, what crops you can produce and how.

Mr. STANGER. For gardening purposes a man wants but a small quantity of land, and he needs that close to a large city or some good market. Ten or 20 acres is sufficient for any gardener to have. To make a success in grain-raising a man must have a greater quantity of land. On 40 acres a general farmer will not make much of a success. He would raise sufficient undoubtedly to support his own family and probably pay the taxes, and maybe pay Mr. Dunbar the interest on the money he would loan him. He might succeed in doing that, but it would be very doubtful when cabbages are selling at 35 cents a hundred here in Denver. Alfalfa is not worth $5 a ton 10 miles from Denver. The wheat is a good crop, and is worth something like 75 cents a bushel or $1.25 a hundred, as you would understand it.

In regard to the distribution of water, the duty of water is the great question that interests us in Colorado.

Senator JONES. I would like you to run along a little further on the line you were talking of now. I infer from what you say that you do not think a man ought to be confined to 40 acres in the arid belt.

Mr. STANGER. No.

Senator JONES. What size do you think he ought to have?

Mr. STANGER. Eighty acres. Forty acres would not be sufficient in Colorado, unless it be near Denver.

Senator JONES. Where it could be used for truck farming?

Mr. STANGER. Yes. If a practical farmer be away from such a market he can do very little on less than 80 acres. Of course he can support a family.

Senator JONES. That is what I wanted to ask. Now you can continue on the other line.

Mr. STANGER. You do not care to hear anything from me about how to distribute the water.

But in regard to the water that we have been using in Colorado I wish to say this: Twelve years ago we had an idea that we were using all the water in Colorado. We knew nothing then about the San Luis Valley. The Platte Valley we knew a good bit about, and I suppose ten years ago we had utilized about all the water that was possible, but we have kept on increasing our farms and putting in cultivation new lands, and we find that we have a gradually-increasing water supply—more than we thought we had then. Experience has developed the fact that we can get along with half the water we used to. The old theory was that a cubic foot of water per second would irrigate about 55 acres of land. That was put as nearly the maximum of the duty of water. Our experience is that we can nearly double that—we can irrigate nearly twice as much land.

Getting down to practical operations I will say this: I have a 320-acre farm. We used on that farm eight years ago 125 inches of water. That is a very indefinite proposition, as the engineers have told you, but it was all the water that would run through our box, and was called 125 inches. That was the water for 160 acres of land, and a great deal of it was a natural meadow, some of it in crops (perhaps 40 or 50 acres), fields, and in orchards. I added to it 160 acres more and dropped

down to 100 inches of water. Nearly 100 acres of it were put in alfalfa and some of it into other crops. I went on a few years longer and used 8 inches on 320 acres of land—240 of it in actual crops. I find that a service of 80 inches of water in this very dry year gives better results than when we wasted the water. It is very much therefore the fault of the individual, a lack of industry and carelessness on his part in the distribution of the water.

Of course crops have to be somewhat arranged so that we can utilize this water on different crops at different times. Alfalfa is a crop that takes about three or four times the quantity of water that wheat would. This year we have irrigated our alfalfa, but I have only cut two crops on account of the lack of water in our ditch. The third crop I shall not cut. I shall not bother with it. I have irrigated for the two crops four times. My wheat and oats were irrigated but once. I had 40 or 50 acres of wheat and had a good yield. We were favored with rain at the proper time.

The main point I want to impress upon the committee is that we have plenty of water in the State of Colorado to utilize all the land now under ditch; but, in my estimation, we have approached the limit of lands that it would be possible to irrigate with the water or moisture that falls in the State of Colorado. To be more definite, there are enough ditches already constructed, or partially constructed, to consume not only the water we could have, but all that we could save. I am speaking now of the Platte. The Arkansas Valley has not utilized the water it has. It is utilizing it on paper, but it is to be determined whether the water can be got down. There is very much sand on that river, and whether they can get the water down on the mesa I do not know.

Senator JONES. You think there are ditches enough in the water-shed of the Platte to use all the water that could be saved?

Mr. STANGER. That could possibly be saved, either in the mountains or on the plains.

The CHAIRMAN. What proportion of the land covered by those ditches is actually cultivated now?

Mr. STANGER. About one-fourth or one-fifth of it.

Mr. CHAIRMAN. It would be four or five times as great an area of cultivation if the water was saved then?

Mr. STANGER. Yes. Our State engineer instructed the water commissioners to give him data in regard to the quantity of land under the ditch, the quantity under cultivation, the quantity in alfalfa and other grasses, and the quantity in other crops. I think it amounts to but one-third or one-fourth of the land that is actually under cultivation at the present time, yet it is covered by ditches.

Senator JONES. That information is already in, I believe.

Mr. STANGER. Yes, I believe it is.

The CHAIRMAN. Outside of the Platte, and outside of the Arkansas, there is a large area of country here. Have you ever taken into consideration the question whether any portion of it might be reclaimed by reservoirs to accumulate the storm-waters.

Mr. STANGER. Yes, I have given that a great deal of attention, and it is possible to do that out on the plains, in our dry streams—those that are dry the greater portion of the year. At certain seasons immense floods come down and if at proper places reservoirs could be constructed that will hold the water, large quantities of water could be stored. Some years ago we had great floods in the streams east of our town, so great that a locomotive going over a bridge could never be found, although the railroad company expended a great deal of money

to find it. If it were possible to save those great floods that come down from the divide and hold them, there would be great quantities of water saved and some very fertile tracts of land taken care of.

The CHAIRMAN. You think it important to investigate that question.

Mr. STANGER. Yes, very.

STATEMENT OF JAMES B. GRANT, OF LEADVILLE.

The CHAIRMAN. Where do you reside?

Mr. GRANT. In Colorado.

The CHAIRMAN. Are you engaged in the smelting business?

Mr. GRANT. Yes.

The CHAIRMAN. Have you given any attention to the matter of irrigation or the storage of water in reservoirs?

Mr. GRANT. Yes.

The CHAIRMAN. Please give the committee the benefit of such information as you may have on that subject.

Mr. GRANT. I own about 1,000 or 1,200 acres of land about 10 miles from Denver, between Littleton and the mountains, in the triangle between the Bear Creek and the Platte. We have no water practically in the irrigating season, for the ditches absorb it all. Sometimes we get one irrigation in the spring from the natural flow, but for the second and third irrigation we have to rely on reservoirs entirely. A number of us there have spent a great deal of money in building reservoirs.

The CHAIRMAN. State what success you have had in storing water?

Mr. GRANT. It is an absolute success as far as storing is concerned, and the only trouble about it is the expense. Of course, where you have a natural reservoir there is no expense except the outlet—cutting under the lowest point, putting in pipes, and having valves to let the water out as you want it; but on this land of mine we have something of a natural site, though not very much. We have to dam on one side entirely. My experience is that it costs $20 per acre for 160 acres of land to build the reservoirs for holding the water for irrigation.

The CHAIRMAN. That is in your locality?

Mr. GRANT. Yes. I have about 1,200 acres of land there, and I expect in time to have plenty of water for it. I have estimates already made on it and have about 300 acres in cultivation.

The CHAIRMAN. It costs $20 per acre to build the reservoir for irrigation?

Mr. GRANT. Yes. Being near the city, I think good land there is worth $75 per acre.

Senator JONES. Where do you get the water for your reservoirs?

Mr. GRANT. From Bear Creek.

Senator JONES. You take it out of the creek in the flood times?

Mr. GRANT. Yes.

Senator JONES. Is that practically a dry stream in summer?

Mr. GRANT. No. It is not entirely dry, but there is not much water during summer in it. We cannot use the water much in winter because the ditches freeze solid, and it costs so much to clean it out that it does not pay to run the water.

The CHAIRMAN. Are you familiar with the topography of the plain between the Platte and Arkansas?

Mr. GRANT. Only in a general way. I have no knowledge in regard to reservoir sites.

STATEMENT OF LEVI BOOTH.

The CHAIRMAN. Where do you reside?

Mr. BOOTH. I reside 5 miles from Denver, on Cherry Creek.

The CHAIRMAN. How long have you resided in Colorado?

Mr. BOOTH. Since 1860.

The CHAIRMAN. Have you given attention to the subject of irrigation and water supply?

Mr. BOOTH. I have had practical experience in irrigating.

The CHAIRMAN. State your practical experience.

Mr. BOOTH. Cherry Creek is a dry creek. I located on a dry creek first. Cherry Creek rises at a point where the bed-rock runs up, and by taking the water from that point and getting it onto the ground you save it from wasting in the sand-bed of the creek. I did that and had reclaimed quite a portion of land until the water was taken away from me by the city company. The question with me, and with farmers generally, is how to save more of the water that is running to waste.

The CHAIRMAN. What is your observation as to the amount of water wasted - is it large or small?

Mr. BOOTH. There is a great deal of water wasted. In the spring, during the irrigating months, probably more than one-half the water runs to waste; the ditches will not hold it. The Platte runs full very often and sometimes runs over its banks. That water is generally running to waste at least a month and a half. It could all be conserved, saved, and used upon our arid plains.

The CHAIRMAN. How?

Mr. BOOTH. By reservoirs.

The CHAIRMAN. Have you had any experience in constructing reservoirs?

Mr BOOTH. No, I have not. All I know is from what I have seen. My idea about it is that we should go in the mountains, not in the deep cañons, however, but take it in the parks where there is a large area of flat lands, dam up the streams and let the water freeze up. It will freeze up in the winter. Then in the spring there is a reservoir for you that will last for a month or two. The ice will melt, the water will run down, and we will get the benefit of it below. That is one way.

Then there are places where large reservoirs can be constructed, and the valley reservoirs here must be constructed on the highest point. My way would be to take the water out onto the divide in a ditch along the apex of the summit, running toward the Arkansas and toward the Platte. There are many such chances to make reservoirs. There I would construct the reservoirs. Then the ditches would run from those reservoirs over the arid plains. I think a great portion of the country that is now worthless between here and western Kansas can be brought under cultivation, and homes made for the millions that are now starving to death in our cities. That is what you want these surveys for, to make small homes for the people, not for speculation. The farmer wants it understood emphatically that he does not want the land to go into the hands of speculators.

The CHAIRMAN. What quantity of land is enough for a man?

Mr. BOOTH. When a man is engaged in general farming, nothing less than 80 acres. If he is gardening, 5 or 10 acres will do. If he is near Denver or some other point where there is a good market, he would not want as many acres.

Senator JONES. Who do you think ought to own the canals or control them?

Mr. BOOTH. I think the State or the National Government should control the canals; at least, they should in such a way that large corporations could not get hold of them, for the man that owns the water owns the land or controls it. Hence the State or the General Government ought to own the land or it should be given into the control of the men who take up homesteads. It is then a question whether the control of the water would not finally get into the hands of the capitalists. My idea would be to have the State control the water. Of course, so far as the construction of reservoirs is concerned, if it is done by the Government, the Government should control them or give them to the State to control, but by no means let them get into the hands of corporations. The reservoir sites must be owned for public use—for the people.

STATEMENT OF BYRON S. WHEELER, OF DENVER.

The CHAIRMAN. How long have you resided in this State?

Mr. WHEELER. Nearly nineteen years.

The CHAIRMAN. Have you had any experience in the matter of irrigation or water supply?

Mr. WHEELER. I have.

The CHAIRMAN. The committee will be glad to hear what you have to say on that subject.

Mr. WHEELER. In regard to irrigation on the dry creeks; I have a ranch east of the town, about 9½ miles, through which runs the bed of one of the dry streams of the plains. Before a ditch was built scarcely ever was there water to be seen on the surface of the creek bed, while at other times the creek would be in a tremendous flood, tearing fences and land away in great quantities. Since the ditch has been built there has been a continual increase of water in the creek—so much so that it is possible to irrigate a good many acres of land from the seepage coming out all along the banks. This comes apparently from lands that had been irrigated miles away—discharging into the creeks—so that it has been possible to again take that same water that had once been used on the higher lands and reirrigate lands lying still lower. That one increase of irrigation by reusing the water is one of the great sources of supply that we will have as we continue our irrigating system. But I suppose Mr. Nettleton wished that I should present my views more on the question of the control that this water shall be put under while we are using it.

For some years I have been associated with the farmers, particularly in regard to that. There is for them a nether millstone, consisting of the intractable things of nature, like the drought, the arid country, the inability of the farmer to always calculate upon a steady flow of water, and an upper millstone in the fact that the water they need so urgently is controlled by men whose only motive can be the money they get out of it. My experience with the farmers is that they are being ground to powder; that they are not getting their crops so that they are able to pay the interest on the money they have borrowed on their 40 or 160 or 320 acres; that the interest of the ditch company is simply as a company to get all the money there is in the water that *they* furnish. So they charge for the water in advance. The farmer *must raise* that money for the water before he has raised anything.

Then he alone takes the chances of getting what he has paid for it. The result of it is that in more than half the cases the man is at a loss five years out of every ten. For the last twelve years there is scarcely a question that the average farmer—not the exceptional farmer, but the average farmer—has been going down hill financially from such causes as these. The water supply is sure to be decreased, not alone from natural causes, but from the cupidity of the company controlling the ditch, in continually extending its area and selling water that it can not deliver, even though there should be a flood in the stream. So that 20,000, or 40,000, or 100,000 acres are added to the area which a given ditch is supposed to irrigate at first and the others then must prorate. The result is that every man under the ditch is put to his trumps to get what he pays for. The farmer you see has to pay in advance; the ditch company sells what it can not deliver. But in any event it gets the money. The result of that is there is a great deal of so-called stealing of water. The farmer's family is dependent on the crop he raises. He must have his crop or else his family will have to go naked or in rags. Yet the water is scarce. The company has prorated it along the line and the cupidity of every farmer is roused to obtain a support for his wife and his children. That is the history of all the old settled portions and largely so already in the newly settled parts of the state.

That conflict rises higher and higher as time goes on. It is the farmer as against the man who has put his money into the ditch. It is not the farmer attempting to defeat the just result of capital. The question for him is as to the livelihood of his family. He needs to curtail the ability of the corporation to do him harm, as it does when it contracts to sell water it can not deliver. The quarrel has grown each succeeding year. So that the great question with us in Colorado is the way these ditches shall be managed. If it be left as at present, it goes against the farmer, because he must devote his whole time digging in the soil and distributing the water he gets in order that he may be able to obtain a crop. His entire time and attention is absorbed in that so that the political aspects and the more general features of the matter, such as the manipulation of legislatures, has gone by the board. The ditch companies have their agents, plenty of them, all round the legislature. There is not on the statute books of Colorado to-day more than one law that fixes a penalty for the ditch company if it oppresses an individual who is using water. To get that law passed, the farmers of the State turned out and labored all winter long, going hungry and scantily clothed during that session of the legislature in order to get it through. They finally succeeded on the last day of the session. While the penalties have been fixed higher and higher by each succeeding legislature against the men who violate any of the rights of the ditch company, the ditch company is making his necessity the pretext for having that water. Still the penalty is increased and his necessity increases. The companies have got the penalties all upon him. He has no recourse upon the company when they fail to perform their part of the contract.

So the farmers pretty generally—I am associated with them in three or four organizations—have come to the conclusion that there must be a radical change in the control and management of the water. Most of them approve of State ownership. They take the model of the United States Government in controlling the delivery of the mails, which is the best possible service at the least possible expense. The Government in some form, whether the United States Government, or the State gov-

ernment, should control the water. Whether any given territory should be segregated into water districts, or be controlled as a whole, is a matter of detail. The point is that the water, as far as it goes, shall be justly distributed by men who have no financial interest at stake; men who are simply there for the sake of the service they are to perform. That would be the consensus of opinion in this State as to the delivery of the water to the farmers.

Senator JONES. Have you not got State officers already to do that?

Mr. BOOTH. Yes; but they have no control of the delivery of the water to the individual farmer. They only control the head-gates of the ditches. The individual farmer is dependent upon the head-gates of his ditch.

Senator JONES. It seems to me that your difficulty is not so much with the distribution of the water as with the prior management, or mismanagement, of the company.

Mr. BOOTH. The difficulty is that the companies are endeavoring to get all the money they can out of it. Somebody should see that each ditch is supplied with its proper proportion of the water. Somebody should go down and see that each head-gate and lateral is properly raised and lowered. It can never be properly done as long as there is a financial interest in it, because, like other business matters, heart never enters into the distribution of water. These companies are not governed by the desire to do right; they are only governed by that which pays best. This is accomplished by delivering the least water for the most money that is possible. Hence the quarrel. It has been proposed here in Colorado that the State should own every ditch and all the laterals; should control every outlet in every ditch from beginning to end, and see to it that the water be distributed according to the land that is under cultivation. It has been heretofore, and is to-day, attempted to hold so called water rights as independent and separate things from the use of the water on the land. The ditch owners assume to say, "We will sell you a water right and give you a piece of paper"—an alleged deed showing that that is your right. Yet a man may sell out the land to another who is ignorant of the water laws, and the second purchaser is thereby left without water. In fact, it has been so arranged that a man has had to pay twice for those so-called water rights, in first buying outright and in after buying over again from the same company. But worse than that, the buying of any water right at all is paying a company that has really done nothing.

The constitution of Colorado declares that the water is dedicated to the use of the people. The doctrine, as I conceive it, should be that when a piece of land is once cultivated with water, the State is interested in seeing that it should never be deprived thereof. Of course, everything should be done to compel the economy of water. While a man's selfishness impels him to get all the water he can, there is but one way to prevent a large waste. If the water were measured accurately to each man as he uses it, and at the end of the season it were ascertained what quantity he had actually used, then he would pay for the actual amount used. In that case the question for him to decide is, "How much does my crop actually need?" He would at once cease to waste the water. In other words, the duty of water would probably be increased to at least twice the amount at present. If the State had the matter under control so that the consumer would pay for what he actually used at the time he paid his taxes, there would soon be universal satisfaction with the system of water distribution.

The CHAIRMAN. How would you get control of those private rights —*buy them up*?

Mr. BOOTH. Even if the State bought them, it would simply give the private company a proper return for their money. But that should not include watered stock. The first dividends of one ditch built here brought in the first year 60 per cent. of the actual cost of the ditch. One of the stockholders said, "The farmers can never stand 60 per cent." So they went to work and increased the stock, and the next year it was but 30 per cent. profit. They then said, "The farmers never can stand 30 per cent.," so they increased the stock again. That time they got it down to 12½ per cent. profit and next year it increased again. Then I believe they got it down to 8 per cent.

Mr. STANGER. Did they not build additional laterals?

Mr. BOOTH. They now say that under that ditch "our stock is only paying 8 per cent. now." But the stock is eight times as great as it was and is eight times what the stock would be if the State had it. If the State took control, it should not pay that ditch company eight times what its works actually cost and give it all of these profits for all those past years. There should be a just estimate put on what it would cost to build that ditch to-day. Pay them their full value for all they have, let the past robbery go, and prevent their future robbery. That's my proposition.

Mr. STANGER. Do you know personally of any ditch company that has got rich?

Mr. BOOTH. No, I do not know of any ditch companies that have got rich, but I know a good many individuals in ditch companies who have got rich. The crying need of this country is State control of the water, rather than any increase in the number of ditches. If reservoirs are to be built to improve the supply of water in the ditches, it becomes necessary to see that the persons using the water have the advantage of it instead of making it another means of increasing the wealth of the few. A man who has 40 acres of land should not be confined to that quantity of water that will just enable him to pay interest to the money loaner. The fact is, that the prosperity of the country depends more on the number of men who are prosperous in it than on the few that are prosperous in it.

Senator JONES. What is your idea of the changes that ought to be made in the homestead law?

Mr. BOOTH. In this section of the country if the Government will guaranty the water to a man, I would say that 80 acres is of more value to him than 160 acres in a country where they depend on rainfall.

Senator JONES. Suppose the Government would not undertake anything about the water?

Mr. BOOTH. Then I think the homestead law should be left as it is. But if the Government would provide means by which water would be put on the land, it might be desirable to reduce the number of acres a man may have. It has been suggested, and I think it will be nothing but fair, that the Government give to the States lying in the arid region the unreclaimed lands that now belong to the nation, binding the State to use all that land for actual settlement as it is made fertile. Then if the General Government wishes compensation, the State can pay back to it a certain amount.

Senator JONES. Why would it not be just as well for the Government to give the land to the settlers instead of to the States for that purpose?

Mr. BOOTH. The only difference would be that the State administration would be nearer home and would plan the further development of the irrigating system more rapidly than the Government would.

The CHAIRMAN. Will you name an instance where any State having public lands donated to it for any purpose has administered them well?

Mr. BOOTH. No, I am sorry to say I can not; from the swamp lands of Wisconsin all the way through.

Senator JONES. I see no advantage to the State in giving it the desert lands unless it be allowed to dispose of them as it pleases. It is one thing to give the lands to the State and let the State give them to people under mortgage. It is another thing to give the lands, the State being bound to give them to some one else under condition.

Mr. BOOTH. The population would thereby be guarantied.

Senator JONES. The Government is guarantying as it is. It is ready to give lands to the people, and the State can not do it any faster.

Mr. BOOTH. Yes; the State would use the increased value of the land in order to put under cultivation more land and to build those reservoirs and ditches.

Senator JONES. You mean tax it with a debt?

Mr. BOOTH. No; that would not make a debt. For instance, if the lands were sold in a certain district to actual users of water the proceeds of those sales would then be turned over to another district.

Senator JONES. You are in favor, then, of the States selling the lands?

Mr. BOOTH. Yes.

Senator JONES. Not giving them away?

Mr. BOOTH. Not giving them away, unless it be for the purpose of development.

Senator JONES. That is another question; whether it is better to sell the public lands or give them away?

Mr. BOOTH. As it is now the State gives 160 acres to the individual, and he turns around and gives the ditch company the very money that we want the State to have in order to develop the ditch.

The CHAIRMAN. In other words, you want the State to become the grand ditch company?

Mr. BOOTH. Either the whole State or its subdivisions. I think the farmers, as a whole, favor the whole State controlling it.

There is another feature I would like to mention. There are new ditches being taken out without any prospect of water during the time it is needed for irrigation, but in which there is plenty of water flowing when it is not used for irrigation. A man comes along to take up a homestead, and they say here is a ditch to supply you with water. He does not wait until it is dry. He goes on and invests the last dollar he has in that homestead, and gets absolutely no show whatever for water. It should be within the power of the State to say, when the waters of a given stream are exhausted, and prevent the further building of ditches under such circumstances, because there will be thousands of men deceived by the over-building of ditches where there is no constant water supply.

Mr. STANGER. Are those extensions of ditches that you speak of theoretical or actual?

Mr. BOOTH. They are actual.

Mr. STANGER. Will you give instances?

Mr. BOOTH. I would prefer not to do so, as there are persons in the room here that would be pretty sure to be hurt. There are many cases I know of in which extensions of the ditches have been made on the lower end where they have compelled those above who have invested their all to go scant of water and let the others below have a still scantier supply.

STATEMENT OF ROYAL A. SOUTHWORTH.

The CHAIRMAN. Where do you reside?

Mr. SOUTHWORTH. In Colorado, 12 or 14 miles from Denver, down the river.

The CHAIRMAN. Have you been engaged in the business of irrigating land?

Mr. SOUTHWORTH. Yes.

The CHAIRMAN. State anything new in this inquiry that you know of.

Mr. SOUTHWORTH. I suppose the object of your committee is to learn facts?

The CHAIRMAN. Yes; give us any facts that you may have.

Mr. SOUTHWORTH. The question is whether the Government could make profitable use of some outlay here in conserving the water. I am a practical farmer, having been farming for fourteen years. In that time I have been connected with various farmers' organizations, and I have been pretty nearly all over this State. I am familiar with the practical use of water. Unless the waters that are annually going to waste now are conserved in some way, fully 25 per cent. of the people now engaged in farming over the divide here, north as far as the Wyoming line, will have to leave. They have already paid for their alleged water rights, but the water does not come with the paper water-right.

Speaking of the prosperity of the farmers I know that many farms are trust-deeded, and not altogether for farm machinery either. Of course the agricultural implement man has a strong hold on the farmers, but the ditch monopolist of Colorado have a much stronger hold. The ditch companies are drawing good interest. I know one ditch in which twenty-seven farmers have been closed down because of trust deeds for water rights.

Senator JONES. They were unable to pay for the rights?

Mr. SOUTHWORTH. They were unable to pay the interest on the trust deeds that paid for the rights. The rights had been paid for. I know other instances where people had to leave their farms where they had even paid for the water rights and could not get the water.

Senator JONES. Why?

Mr. SOUTHWORTH. The companies change hands from one to another. They bond a ditch, for instance, and the ditch is sold to another company, and the new company is not going to put out the money necessary to run the ditch, claiming that they will only put out the money necessary to repair the ditch. This is done when the farmers have in their contracts the clause that they will only pay a certain figure per year, and no more. Then they say "if you do not permit assessments to be raised we will not permit you to have any more water." I believe this land is going to be used some day and that it will not be allowed to lie idle, but we want it put in such shape that whatever expense the Government is at, the people will get the benefit, and that the men who till the farms may not have to pay interest to somebody else for handling it.

With regard to the watering of stock I have a word to say. I am under a ditch that I helped to build. That ditch is watered at a great deal more than has been stated here. That ditch cost only $30 a share and is selling at $300 a share. They profess to give a certain number of inches, but they do not do it. Men have lived near me who have worked for years and years and struggled hard, and have finally had to give up. This thing has gone far enough in this State. The farmers

are willing to pay a reasonable price. The ditches have been built at an average cost of $2 or $2.50 an acre and the farmers under the water-right system have to pay $10 an acre and then do not get the water. We can grow crops here and the crops that we do grow are of a better quality than those of any State I have lived in in the East, as Michigan and Illinois, in both of which States I have farmed. While we can raise better wheat, oats, and barley, it costs us considerable to grow it. Many of our farmers sell their crops for less than it costs to grow them. The farmers therefore are going constantly down hill. The price of water has been going up while the prices of the crops have been going down. So if you now find a farmer that is prosperous he is making his money on something other than his farm. Besides they think that if there is to be any speculation in land they ought to be allowed to speculate in lands as well as the companies that own 40,000 or 50,000 acres.

The CHAIRMAN. Would you make any change in the homestead law?

Mr. SOUTHWORTH. I have arrived at this conclusion after farming for many years. I have several times 40 acres myself and it is near this city, but it is a drag to me. The question is, why should not a farmer be able to pay his help as well as any other man? Still, they can not do it.

The CHAIRMAN. Are you familiar with the region of country between the Platte and the Arkansas—those plains that have no running streams in the dry season?

Mr. SOUTHWORTH. Yes, I have been all over that country considerably.

The CHAIRMAN. What are the opportunities there for the storage of the storm-waters?

Mr. SOUTHWORTH. There are many opportunities for the storage of water. On the question of storage my opinion is that the proper place to commence would be at the heads of the streams, and to store there all that could be stored where you can find a place. If you find a place in the mountains, that is the place to begin with, because in storing there you help all the people below.

The CHAIRMAN. And there is less evaporation there?

Mr. SOUTHWORTH. Yes; and the higher up you get the reservoir the more people it will help.

The CHAIRMAN. Do you think the area of the farming lands can be extended on the Platte beyond the lands now under ditches?

Mr. SOUTHWORTH. In time it can be; only, however, under State and not under corporation control. If you will let the State do it, when a farmer comes in in the fall and pays his taxes for the county government he pays also for the water, not for the quantity he thought he might want to use, but for what he actually used. As it is, he has to pay in the spring in advance oftentimes for what he will not use at all.

Senator JONES. You think, then, it would be better for farmers to get their water year by year?

Mr. SOUTHWORTH. Yes. There is nothing in this water-right business except robbery. We can bring plenty of facts to prove it.

The CHAIRMAN. How would it do for the farmers to build their own ditches?

Mr. SOUTHWORTH. The place where that plan is adopted here is the only place in Colorado where the farmers are prosperous.

Senator JONES. Why can you not all do that?

Mr. SOUTHWORTH. The corporations have got ahead of us and have bought up all the places.

Senator JONES. There is a law-making power in every State.

Mr. SOUTHWORTH. The farmers tried to get something last winter whereby they might bring the corporations tc time or punish a corporation for selling water away from them. But they can not do it. Corporations steal our water. They have burnt up thousands of trees and thousands of acres of alfalfa.

Senator JONES. It seems to me that the people of Colorado ought to be able to elect people to represent them.

Mr. SOUTHWORTH. We do not have time to pull wires.

Senator JONES. There are as many farmers as there are ditch owners, at least.

Mr. SOUTHWORTH. Yes; but when you put the ditch owners and railroaders together they can outwind us.

The CHAIRMAN. You think where communities own the water and manage it themselves they have prospered?

Mr. SOUTHWORTH. Yes; they may have occasional hard times when the water is not to be had at all, but they are the only farmers that have prospered within the arid section.

STATEMENT OF W. E. ALEXANDER, OF DENVER.

The CHAIRMAN. What is your occupation?

Mr. ALEXANDER. I am in the real estate business.

The CHAIRMAN. Have you given attention to the storage of water?

Mr. ALEXANDER. I represent a company that is about to begin operations next week. It is in Cherry Creek Cañon, about 30 miles south of Denver.

The CHAIRMAN. What kind of stream is Cherry Creek?

Mr. ALEXANDER. It is usually a dry creek, and it is for the purpose of saving the flood waters that this enterprise is undertaken.

The CHAIRMAN. What is the name of the map you present?

Mr. ALEXANDER. It is called the "map of the Denver Reservoir and Canal Company; reservoir site, Douglas County, Colo."

The CHAIRMAN. What is your proposition?

Mr. ALEXANDER. To dam up this Cherry Creek Cañon, take them off through a ditch and save the waters. We have our surveys made.

The CHAIRMAN. Is Cherry Creek used for irrigating purposes?

Mr. ALEXANDER. There are some ditches from it.

The CHAIRMAN. You propose to take the flood-waters?

Mr. ALEXANDER. Yes.

The CHAIRMAN. How much do you expect to get?

Mr. ALEXANDER. Probably 250,000,000 cubic feet.

The CHAIRMAN. Is there flood-water enough for that purpose?

Mr. ALEXANDER. The reservoir will hold that much.

The CHAIRMAN. Is there probably flood-water enough to fill it?

Mr. ALEXANDER. There is probably enough to fill it four times a year.

The CHAIRMAN. How much will you be likely to irrigate?

Mr. ALEXANDER. Thirty thousand acres.

The CHAIRMAN. At what cost?

Mr. ALEXANDER. The reservoir and ditch will probably cost $150,000 to $200,000.

The CHAIRMAN. That is $3 or $4 an acre?

Mr. ALEXANDER. Yes; of course that is only an estimate. Before we can get through it will probably cost more than that.

The CHAIRMAN. Do you think you can do it for $5 an acre?

Mr. ALEXANDER. Yes. I have here a map of the land to be irrigated by the reservoir. Here are the plans of the dam which we intend to build so that it will not wash away.

The CHAIRMAN. Are you going to build it of masonry?

Mr. ALEXANDER. Yes; all solid masonry and concrete.

Senator JONES. How much land is it intended to be irrigated by this?

Mr. ALEXANDER. Probably from 30,000 to 35,000 acres. I can furnish you a full set of those maps and plans. We are going to cut that land up into 40-acre tracts. We own about 60,000 acres.

Senator JONES. Are you going to sell the water-right with it, so that the people are going to have the dam when it is done?

Mr. ALEXANDER. Yes.

Senator JONES. You are not going to continue a water company, but will let the people have it?

Mr. ALEXANDER. Yes. But it will be, of course, a benefit to the ditch company. The State was offered the chance to build this but it would not do it. The legislature would not pass the bill that gave them the chance. So we took it up and propose to do it ourselves. That is the only chance for this country to have the water properly utilized.

The CHAIRMAN. Are you familiar with the topography of the country?

Mr. ALEXANDER. Yes.

Senator JONES. Do you think that the opportunities for reservoirs are extensive?

Mr. ALEXANDER. Yes; there are many that I know of. We have an immense water-shed there; probably 200 square miles.

STATEMENT OF ROBERT G. DILL.

The CHAIRMAN. Have you given any attention to the subject of irrigation?

Mr. DILL. I have.

The CHAIRMAN. Are you a farmer?

Mr. DILL. No.

The CHAIRMAN. What is your occupation?

Mr. DILL. I am now a printer, but have been in the Government surveys, and have been all over the Arkansas Valley from one end to the other.

The CHAIRMAN. What do you think of the Arkansas Valley in reference to opportunities for storage? We have a description of the upper Arkansas from Leadville here, but we would like to have a description of the lower Arkansas Valley.

Mr. DILL. My occupation at the time I was in the service of the Interior Department took me from Pueblo to the State line and down into Kansas very frequently. My belief is that in that section of country, with a proper system of canals and storage reservoirs, almost the entire basin on the north side of Arkansas River can be irrigated.

The CHAIRMAN. How far down?

Mr. DILL. As far as the State line.

The CHAIRMAN. How is it beyond the State line? Is there no water left for Kansas?

Mr. DILL. My observation as a newspaper man has led me to believe,

at any rate, that the water finds its way back to the river. I was here when Greeley had only one canal and it now has four. The one canal exhausted the Cache la Poudre, and that stream now supplies four.

The CHAIRMAN. You think there will be a supply for Kansas after enough is taken out for Colorado?

Mr. DILL. Yes.

The CHAIRMAN. In laying out their ditches some of the schemes presented to us contemplate the construction of reservoirs along the line. Have you been on the divide between the Platte and Arkansas?

Mr. DILL. Yes; all through it.

The CHAIRMAN. What are the opportunities for storm-water reservoirs?

Mr. DILL. They are frequent. The only ones I can testify to are those that occurred to me in surveying Government land. Of course, we frequently came to depressions and had to make calculations. I have not surveyed much above Pueblo but have been over the ground, and from the mouth of the Cañon to the State line there are many natural depressions that can be inclosed at the lower end with very little labor, but it needs a canal the entire length.

The CHAIRMAN. A canal to take water from the Arkansas River?

Mr. DILL. Yes, and along the divide.

The CHAIRMAN. They might be supplied by storm-water?

Mr. DILL. Yes; there are frequent storms there, on the south side of the river particularly, but the opportunities are fewer there because the ground on the south side of the Arkansas River, from Trinidad to the State line, is broken up into cañons from 150 to 350 feet down to prairie. There is one place where you could inclose 500 acres but there is no land to irrigate.

The CHAIRMAN. Have you ever been a practical farmer?

Mr. DILL. To some extent, in Pennsylvania.

The CHAIRMAN. I mean have you farmed here?

Mr. DILL. No.

The CHAIRMAN. Is there anything further you would like to suggest?

Mr. DILL. The only general idea that I got when I was engaged in surveying in that country was, that a canal from the mouth of the Arkansas down to the State line would irrigate, with proper storage reservoirs, the entire country down to the Arkansas River without materially interfering with the Arkansas itself. On the south side of the river there would be frequent opportunities. They are not so frequent until you get down to the Kansas line, and then there would be about equal opportunities.

STATEMENT OF PLATT ROGERS.

The CHAIRMAN. You have given considerable attention to the laws regulating the use of water?

Mr. ROGERS. Somewhat.

The CHAIRMAN. And to irrigation?

Mr. ROGERS. Yes.

The CHAIRMAN. Speak to the committee of these subjects in any direction in which you may feel interested.

Mr. ROGERS. There is hardly much that I could add in a legal way to enlighten the committee, but it has occurred to me that there are some rules of law in this State that might have influence in carrying

out this scheme of reservoirs. The statutes of Colorado and the decisions of the courts take the position that a ditch owner is nothing more or less than a common carrier, and that he is simply entitled to make a charge for the carriage of the water. In other words, it is declared by the constitution and enforced by repeated decisions that the water is the common property of the people of the State, and that therefore it is incapable of private appropriation; that it must be put on the land for the purpose of use, and that the owners of the ditch perform no function except to carry it from the stream to the place where it is used. For that they are entitled to pay, and for nothing else. That being so, the county commissioners are vested with authority to fix the charges in case there is a difference between the user and supplier of water. In other words, the rule already applied to railroads is made to apply to ditches. I think that in actual operation this is an obstruction to the building of ditches for the revenue to be derived from the ditches simply as such. My experience is that the large ditch companies in this State have expected to get their revenue, and in fact have got revenue, from the fact that they are the owners of large bodies of land lying under the ditch, and that, save for the ownership in that land, the ditches would have not been constructed. So that if the question were presented now in respect to the use of large sums of money for the building of ditches, the right and power being in the people or in the county commissioners, that right and power would act as an obstruction, because the companies have not the right of making such rates as they think will compensate them for the construction of a ditch.

The CHAIRMAN. What obstruction would it be if it were organized with the view of disposing of the water right and of the whole property?

Mr. ROGERS. That is the very question, whether the courts would allow that to be done. The supreme court has practically said that any person that needs water may have it at rates to be fixed by the county commissioners, and that he need not take the contract. The ditches being nevertheless constructed the consumer of the water will not apply for a contract when he can apply for a delivery at the rate per annum that the commissioners will fix.

The CHAIRMAN. That will not prevent people combining and supplying the water themselves.

Mr. ROGERS. No. The difficulty is that after all there have been those who have not taken water under the terms, and who, when the ditch is constructed for the first time, say that they will take it for the rates fixed by the county commissioners.

The CHAIRMAN. Is it clear that the county commissioners will fix rates that will not be sufficient to pay for the construction of the ditch?

Mr. ROGERS. It is said that they have fixed rates here that will not pay for the construction of the ditch.

The CHAIRMAN. Then how do you reconcile your statement with those of several persons here that the ditch companies are charging too much and have a monopoly?

Mr. ROGERS. I do not attempt to reconcile the differing statements of some people. I would have to reconcile many things that do not seem to conform to nature if I had to do that.

The CHAIRMAN. Is there any instance of the supervisors fixing the rate?

Mr. ROGERS. I am told that the rate fixed by the county commissioners in this county on the High Line ditch is not sufficient. This

ditch company, and it is true of all others, have been able to recoup themselves fully and amply by reason of the increased value of the land that lay under the ditch because they always had the foresight to acquire a large body of land under the ditch. I am not stating this as being actually true but it is a matter that is current.

The CHAIRMAN. Suppose the ditch company here should take out a ditch and should make contracts with land-owners sufficient to use the water of the ditch, would the supervisors have any authority to take it away from the parties who had contracted?

Mr. ROGERS. No.

The CHAIRMAN. It will be only when there was a surplus?

Mr. ROGERS. Yes, it must be shown that there is water to be had.

The CHAIRMAN. That would only treat with the surplus that had not been contracted for?

Mr. ROGERS. That is all.

The CHAIRMAN. Practically that is not likely to become a very serious question?

Mr. ROGERS. I do not know that it is; because instances of the building of ditches by speculative companies, purely as such, has really not occurred in this State.

The CHARMAN. Is it desirable that it should?

Mr. ROGERS. As land is taken up now it must be done because there is not land to be had otherwise.

The CHAIRMAN. The people have the land, have they not?

Mr. ROGERS. Yes, but these lands were obtained by taking the land of railroad companies.

The CHAIRMAN. What is to prevent the people from combining to make ditches?

Mr. ROGERS. That is another scheme entirely. If you should start by building a ditch without making some arrangement beforehand, the returns on the investment would not be assured.

The CHAIRMAN. In other words, if a person should attempt to dig a ditch and charge arbitrary rates, the board of supervisors could regulate him and prevent a monopoly rate?

Mr. ROGERS. Yes.

The CHAIRMAN. Is not that wise?

Mr. ROGERS. Yes.

The CHAIRMAN. I see nothing wrong about that.

Mr. ROGERS. I am simply showing that this it is that stares in the face a purely speculative company.

The CHAIRMAN. But it does not affect the others?

Mr. ROGERS. I do not know that the purely speculative kind of companies are coming in. This question leads to this view in my mind. The difficulty which I see about Government aid in the matter of these reservoirs is, that you are dealing with a commodity that is common to the entire body of the people, and to which different legal rules attach from anything else with which we have to deal. There is no other property in this country to which private proprietorship may not be affixed, except this single element of water for irrigation, unless you take the public streams in the State. You are, therefore, dealing with something that all the people have an interest in and concerning which you can not acquire a title. You have to supply this water at minimum rates. That being true, the question is whether you can get a company to take the risk of putting in the ditches upon a bare return of their money with a low rate of interest.

The CHAIRMAN. I hope there will not be a company in Colorado that

will put in water depending on speculative rates. What difficulty does that put in the way of the Government in surveying this land for the purpose of determining what land could be irrigated and what not; taking the gauge of your rivers, determining the amount of rain-fall by experiment; estimating the quantity of water you will get, and then giving out all this information, any more than there would be in surveying it for geological or topographical purposes?

Mr. ROGERS. There is nothing whatever in the way, but I have not shown you the end to which I was coming. It is this: that on account of the small return coming from ditches and reservoirs, it is doubtful whether companies will take hold of these investments. All these things hamper capital. I am not speaking for capital, at all, because I believe in the declaration of our State constitution; but is not the Government as much interested in providing the means by which the water is stored as in getting at the data by which it may be stored?

The CHAIRMAN. We have not that question before us yet. The Government has not determined to do it.

Senator JONES. You think there is no speculative element in the companies? A gentleman testified here to-day who seems to be intelligent and who said he had dcontrol of ditches. He said that his company was get $800,000 for what cost them $300,000. It would seem to an outsider that that was somewhat speculative.

Mr. ROGERS. But he had not sold the water.

Senator JONES. There certainly seems to be an opportunity for speculation in that?

Mr. ROGERS. If carried out.

Senator JONES. He is carrying that out, is he not?

Mr. ROGERS. I doubt if there is very much land there brought under cultivation at this time.

Senator JONES. He seemed to be pretty well satisfied with it.

Mr. ROGERS. There is no question that he should be satisfied with it, if his scheme carries.

Senator JONES. There was another gentleman testified here that the rates paid for water were from $5 to $10 an acre. I asked the cost of a number of the ditches and the cost appeared to run from 50 cents to $2.50 an acre, and it seems to me that there is some opportunity for speculation in that?

Mr. ROGERS. Yes; but this remains a fact, that they are subject to legislative control in respect to their charges, absolutely, through the county commissioners. I am not saying anything pro or con about it, but these are the laws.

Senator JONES. I am very glad they are.

Mr. ROGERS. There is no objection to them. The constitution was very wise in saying that the water belonged to the body of the people, and that it can only be taken for beneficial purposes. It seems to me wise in regulating the charges for the transfer of water. But I am discussing the point whether men who are looking for the return of their money will invest in ditches. I am not speaking against the justice of the matter because I think it is right, but I do not see that capital will come in to invest in business of that kind.

The CHAIRMAN. I think it will come in while a man can build a ditch that is going to cost $2 an acre, of which he can sell the rights to the land-owners at the rate of $6 to $10 an acre.

Mr. ROGERS. Now you are speaking of profits and ditches. According to the statement of Mr. Southworth, and the other gentlemen who testified on his side, they would reduce the profits to a minimum. They

organized a farmers' protective union to induce the legislature to give them practically the water for nothing.

The CHAIRMAN. There have been cases where they went on and dug their ditch and sold the water to the land-owners as they went along. In that case the people will own the land and the ditch. What have the legislature to do with that?

Mr. ROGERS. Nothing.

The CHAIRMAN. Is not that a pretty good scheme?

Mr. ROGERS. Yes, if you can always develop that scheme; but I think there was only one scheme in which that was developed.

The CHAIRMAN. The legislature ought to interfere when the land and water are divorced and an exorbitant charge is made for water.

Mr. ROGERS. But you must remember that the capital that goes into ditches is not capital invested from here. It is capital that comes from outside. I am not a capitalist, but I have heard some who were speak of this. It is only within a few hours that I have heard gentlemen discussing this very matter, and that was one of the schemes that stood in the way. The county commissioners' authority led him to reject the security, except so far as the land lying under the ditch was concerned. The ditch as a ditch he entirely rejected. There are some other legal questions. You suggested the situation of New Mexico and Kansas. To my mind that is simply a temporary disarrangement. The water has not yet found its natural channel of seepage, but when the Rio Grande is taken over the San Luis valley and makes, as it will, the reservoir for New Mexico, then they will get their quantity of water, because it will be divided through the proper irrigating seasons.

Senator JONES. Have you any facts to show that?

Mr. ROGERS. I think Mr. Nettleton has facts to show that at a certain point in the Rio Grande River, where the bed-rock comes up, the volume of water is materially increased.

Senator JONES. It might be that it might increase without becoming a full volume.

Mr. ROGERS. There is a certain amount of water that is used up in plant life and the rest of it must follow the ordinary law of nature.

Senator JONES. And if the plant life exhausted all the water, that would leave nothing for the Mexicans?

Mr. ROGERS. The State engineers have shown that 300 acres were served by 1 cubic foot of water, because the water gets back to the river.

Senator JONES. That might be accounted for in the way you suggest, and might be accounted for in half a dozen other ways.

Mr. ROGERS. There is this other suggestion, that if these reservoirs are to be built and the Government is to give its aid, even to the extent of making the surveys, I think it might be a wise provision (and I think the engineers would agree with me) to arrange that most of the water should be used in the ditches up the stream, not only during the irrigating season, but when the water can be run with safety, that is, when it does not freeze, etc. We get an enormous amount of water from seepage, from the effect of building ditches on the high land.

Senator JONES. You would not increase the water supply?

Mr. ROGERS. You would increase it at the needed time. Of course you would not increase the amount of rain-fall, but if you get the water on the upper lands, so that they become thoroughly soaked, then there is not so much excessive moisture at other times.

The CHAIRMAN. That is a good suggestion, that if they would, in the non-irrigating season, soak the land pretty well it would be better for the land.

Senator JONES. You must not do that so much as to injure the lands.

Mr. ROGERS. Of course it must be done with due respect to other interests. In respect to the legal phases of the matter, I am giving you my experience in talking with the people.

Senator JONES. What is your proposed remedy for that?

Mr. ROGERS. I am not proposing any remedy except for you to consider whether the Government should take any further interest in these reservoirs after you have surveyed the sites, etc., whether you should leave them to the control of the State or otherwise. It is rather anomalous to say that common property shall be for any time whatever subject to the control of corporations.

The CHAIRMAN. I think your laws are very good. If they were adopted throughout the whole arid region, capital would be much more safe in its investment than if it came in here with the object of monopolizing. If a company constructs a ditch and sells the water rights to the people as it goes along, and lets them have the ditch when it is constructed, that will give margin enough to give capital its full profits. The only difficulty is ihat people will be willing to give at the rate of $10 or $15 for what will only cost perhaps $2. You can go anywhere and sell the water rights as fast as you construct the ditches and the ditch will be sold at a good profit, and the people will have it when it is done. That ought to satisfy capital, and it appears it is already satisfying capital in your State, because we have had three or four instances brought before us this morning where companies started to get contracts before they got the ditch. They got them and put in the money to build the ditch and are making 200 or 300 per cent. on their investment. I do not see anything in that in the way of discouraging capital, but I dislike to make it possible for speculators to come into this State and sell it out and thereby create here a race of peons.

Mr. ROGERS. That leads to what I was coming to. That is, whether the State or General Government should be the owner.

The CHAIRMAN. What is the objection to the people themselves owning it?

Mr. ROGERS. That is another name for it. That is a different question from capital coming in to invest.

Senator JONES. It is for you people to say whether the State will own these ditches or not. The Federal Government has nothing to do with it.

The CHAIRMAN. The best thing is for the people to own it themselves.

Mr. ROGERS. The question is whether the Federal Government has nothing to do with this. The Federal Government purchased this land and it might make it available.

Senator JONES. What do you say about the statement made here this morning about the stock of the ditches being watered 300 or 400 per cent.?

Mr. ROGERS. I do do not know anything about that. I do not know whether it is true or not.

Senator JONES. You do not know any instance of that kind?

Mr. ROGERS. I do not. I think it quite true that there have been instances where there have been extortionate amounts charged for water. That may be true, but I do not know of any such instance as is spoken of. The largest value that I know of was where there was a combination ditch on the left hand of a creek where a water right is deemed worth $1,200 for 80 acres. It is an enormous price, but it is purely a private affair. There is no company taking this money. It goes back to the farmers living along the line of the ditch. It is one of the oldest ditches in the State.

Senator JONES. Still owned by the farmers?

Mr. ROGERS. Yes; the highest value that I know of is on these mutual ditches, that is, ditches built by combinations of farmers, but usually taking a corporate name, with officers, by-laws, etc., and where each share that is issued to represent capital stock also represents interest in the water. The certificate is a contract for water and at the same time it is a share of stock in the company. It performs a dual function.

Mr. SOUTHWORTH. Would not those farmers in selling their water rights virtually sell their farms?

Mr. ROGERS. What farms do you mean?

Mr. SOUTHWORTH. The farms along mutual farmers' ditches—the left hand or any other like it. Would not the sale of the land leave the farm valueless; that is, without water?

Mr. ROGERS. There are some grounds for saying that; I should say yes.

Mr. SOUTHWORTH. No farmer could sell his water without selling the value of his farm.

Senator JONES. Unless he can replace his farm.

Mr. SOUTHWORTH. But he could not do that.

Mr. ROGRS. Perhaps not, on that ditch.

Mr. BOOTH. How is it about paying $30 an acre for the right to use water without getting any stock in the ditch at all? What worth is it to those who pay? They merely pay that for the right to use the water, and they get nothing only the right to buy the water and afterwards pay for it yearly.

Mr. ROGERS. Mr. Booth is referring to the ditch built by an English company here at a very heavy expense. They had to take the water out of the cañon and had much rock work about it. As I understand from the statements made by the officers of that company, that ditch, as a ditch, has not, at any time since its construction, paid. That is one instance I had in view of the failure of the ditch, as a ditch, to pay.

Senator JONES. Is the statement correct that has been made just now that there have been $30 an acre paid here by the people under the ditch, for the privilege of buying the water?

Mr. SOUTHWORTH. More than that in many instances.

Senator JONES. And then the purchaser has had to pay $30 an acre annually for the privilege of getting the water?

Mr. BOOTH. No; from $1.75 to $4.50 per acre.

Senator JONES. In addition to the original price?

Mr. BOOTH. The $30 an acre gave you a perpetual right to buy the water—you are not buying the water itself. The buyers get nothing, only the right to buy the water, and pay for it yearly afterwards.

The CHAIRMAN. Witnesses who were here this morning spoke of getting a right in the ditch.

Mr. ROGERS. There are different systems about that.

Senator JONES. After a man pays $30 an acre who regulates the price he shall pay for the water?

Mr. ROGERS. The ditch companies.

Mr. TAYLOR. They are not allowed to do that now under the present statutes, are they?

Mr. SOUTHWORTH. They are if they stick to the contract on both sides.

Mr. TAYLOR. That is, if the party chooses to do it; but he can demand water although he may not have paid the $30.

Mr. SOUTHWORTH. He can demand water, but it has broken up every man who has tried it in the court.

Mr. ROGERS. As I understand it, our courts have held that the companies can not exist on the $30 an acre?

Mr. SOUTHWORTH. Yes.

Senator JONES. And they are regulated by the commissioners?

Mr. ROGERS. Yes.

STATEMENT OF E. S. NETTLETON, OF THE U. S. IRRIGATION SURVEY.

The CHAIRMAN. What is your occupation?

Mr. NETTLETON. I am a civil engineer.

The CHAIRMAN. Are you connected with the Government Irrigation Survey?

Mr. NETTLETON. I am the supervising engineer for the eastern division of the arid region.

The CHAIRMAN. You are quite familiar in a general way with the arid regions of Colorado, are you not?

Mr. NETTLETON. I am.

The CHAIRMAN. Have you prepared some facts for the committee in writing in regard to it which you will furnish the committee?

Mr. NETTLETON. I have some facts that I think have not been put in; some statistics with regard to what is called seepage—the return of water to the stream after it is once used.

The CHAIRMAN. You have that information tabulated?

Mr. NETTLETON. Yes; I made an experiment on the Cache la Poudre four years ago and I am going to make another one next October, that is, four years later on the same stream, to see whether there is any increase or decrease.

The CHAIRMAN. Will the facts drawn out there be instructive as to what may be expected lower down the river, as in Nebraska and Kansas?

Mr. NETTLETON. It may be, providing the land adjoining it is irrigated. I suppose seepage comes from the irrigation of land.

The CHAIRMAN. Then your observations lead to the conclusion that the irrigation of land in Colorado would not necessarily deprive the people of Kansas and Nebraska of water?

Mr. NETTLETON. It might at certain seasons of the year, but I think the effect will be that they will have a more uniform flow. They will have a less flow during our flood time here and a greater flow during our low water here.

The CHAIRMAN. Will the same be true as to Kansas; that is, down the Arkansas?

Mr. NETTLETON. Yes, providing that valley is irrigated to the same extent that the Platte Valley is.

The CHAIRMAN. You have traveled considerably over the State of Colorado and Western Kansas and Nebraska?

Mr. NETTLETON. Yes.

The CHAIRMAN. What is the result of your observation with regard to the storing of storm waters, independent of the rivers, that have been testified to?

Mr. NETTLETON. I believe that that is practicable in a great many cases.

The CHAIRMAN. What is the character of the places where it is practicable?

Mr. NETTLETON. It will be generally done in the ravines that bring this storm water in from the prairie country or the highland country.

The CHAIRMAN. You have been here a long time?

Mr. NETTLETON. Twenty years.

The CHAIRMAN. What do you say of the quantity of this storm water that falls?

Mr. NETTLETON. Our heavy storms occur in the summer; generally during the latter part of June and July. It is the storm water that falls at that period of the year that will have to be stored.

The CHAIRMAN. What is the difficulty about distributing the water on the land, or is there any difficulty by reason of the storms being sudden and rapid? Do you get a natural and fair distributing, or does it come in violent storms?

Mr. NETTLETON. These storms last for a few minutes only and are very violent, and a canal could hardly carry the water more than a mile or two; but if held in a reservoir, that water could be used afterwards.

The CHAIRMAN. Does it come so rapidly as not to be useful in fructifying the soil?

Mr. NETTLETON. Not only is it not useful, but many times it is destructive.

The CHAIRMAN. It passes off rapidly and does not penetrate much into the soil?

Mr. NETTLETON. That is the case.

The CHAIRMAN. If this rain-fall came at the right season and was properly distributed and soaked into the ground, it would be much more useful?

Mr. NETTLETON. Yes. I think the amount of rain and snow we have in a year if properly distributed would very nearly grow a crop without irrigation.

The CHAIRMAN. And you think this can be remedied to a considerable extent by reservoirs in the heads of ravines, that will detain the water, and from which it can be distributed through the ditches over the land?

Mr. NETTLETON. Yes.

The CHAIRMAN. We have information in writing, I believe, as to reservoirs along the streams. I do not care to ask you about that matter. Have you anything to add orally to what you will probably present in writing?

Mr. NETTLETON. I think not.

Senator JONES. Have you any idea of the proportion of water that escapes by seepage—the proportion of water that is used in irrigation that would ultimately find its way back to the streams? Have you formed any conclusion as to the amount that would be used up in plant growth?

Mr. NETTLETON. Much water escapes through ditches; more in the new ditches than in the old. Much water is wasted in irrigation. To-morrow I can show you how the country is being flooded by over-irrigation. Instead of finding its way to a natural channel, that water makes bogs and swamps. Those places are filled up by percolation through the soil, by the over-irrigation of the country surrounding them.

The CHAIRMAN. Has any attention been paid in such places to drainage?

Mr. NETTLETON. Yes; in many places we have spent almost as much money in drainage as in irrigation. That will be especially true, I think, of the San Luis Valley.

The CHAIRMAN. What is the effect of too much irrigation, allowing the water to remain on the land to form pools?

Mr. NETTLETON. Too much irrigation washes the land; washes out the fertilizers and makes the land cold and unproductive.

The CHAIRMAN. Has it gone to the extent that it effects the health of the people in any part of the Territory?

Mr. NETTLETON. I think it would do so in any country than an arid country or a country like this. I think there would be more or less malaria in any other country, though I have not heard of any countries of this altitude being affected that way.

The CHAIRMAN. They find in California that drainage is necessary, and that with irrigation and drainage they have not only prevented any deleterious effects so far as earth is concerned, but that it has improved the health of the country. That is very marked in Kern County, Cal., where they could not live at all until it was irrigated. By irrigation and drainage it has become one of the healthiest parts of the State.

STATEMENT OF JOHN CHURCHES.

The CHAIRMAN. What is your occupation?

Mr. CHURCHES. I am a farmer.

The CHAIRMAN. Have you had experience in constructing reservoirs?

Mr. CHURCHES. Yes.

The CHAIRMAN. State your experience.

Mr. CHURCHES. I got a lease from what was known as the Mineral Land Company about ten years ago, and laid out $3,000 in constructing a reservoir. But the freshets and storms in June and July cut it out again and caused a great expense in repairing; in fact, they cut it out so many times that I could not stand it any longer. It is a large reservoir, about three-quarters of a mile long and half a mile wide or a little over, and will hold about 85 feet in depth of water in that basin.

The CHAIRMAN. How high is that dam?

Mr. CHURCHES. It is a natural dam, a natural depression between the two mountains. It is in Jefferson County and situated on Ralston Creek.

The CHAIRMAN. How did you make the outlet?

Mr. CHURCHES. By a cut. I intended to make a tunnel underneath, but my money would not hold out and I did what I could with that cut.

The CHAIRMAN. If a proper tunnel were secured by an iron pipe cemented in and constructed securely, I suppose you could make it useful?

Mr. CHURCHES. Yes.

The CHAIRMAN. You did not have money enough to construct it properly?

Mr. CHURCHES. That was the trouble.

The CHAIRMAN. It is about 85 feet deep, you say?

Mr. CHURCHES. About 85 feet, the surveyor says it is.

The CHAIRMAN. How many acres are there in it?

Mr. CHURCHES. It is about three quarters of a mile long and half a mile wide.

The CHAIRMAN. That would irrigate a large quantity of land?

Mr. CHURCHES. Yes.

The CHAIRMAN. The Ralston would not furnish much water for irrigation in the dry season?

Mr. CHURCHES. No; this reservoir is above all other ditches. My

own property is 640 acres. There are several thousand other acres that are lying there that can be watered from it. All I should ask would be my share like the rest. I would gladly give my share to some parties to put it in running order.

The CHAIRMAN. Could you not get the land owners there to join with you in constructing a proper reservoir?

Mr. CHURCHES. They are too much like myself. They are too poor.

The CHAIRMAN. How much would it irrigate?

Mr. CHURCHES. I should think it would irrigate 4,000 or 5,000 acres.

The CHAIRMAN. It is all private land, is it?

Mr. CHURCHES. The biggest part of it is.

The CHAIRMAN. Suppose there are 4,000 acres; what would the land be worth if irrigated?

Mr. CHURCHES. They are selling lands as high as $50 an acre down under the ditches and this would be just as good land if irrigated.

The CHAIRMAN. That would be a very good water right, would it not, if this were made all right?

Mr. CHURCHES. Yes.

The CHAIRMAN. Suppose you should give away half your land (all you people that have the land) and make all the land worth $50 an acre, you would have enough left to get rich on?

Mr. CHURCHES. Yes; but it would be bad policy to give it away to those that had no money.

The CHAIRMAN. I should think that with that amount of good land and something to irrigate it, you would be able to make terms with somebody that would complete the reservoir.

Mr. CHURCHES. I think if we could make terms with Uncle Sam, he would be the best person.

STATEMENT OF P. H. VAN DIEST.

The CHAIRMAN. You have given some attention, I understand, to the subject of artesian wells in this State?

Mr. VAN DIEST. Yes.

The CHAIRMAN. Will you please state to the committee such facts and views as you may have on that subject.

Mr. VAN DIEST. I have given some thought to the flow of water. I have had something to do in India with artesian borings and gathered some statistics about the amount of water which percolates the lower strata. We found, for instance, that in the Paris and London basins, by carefnl observation it was ascertained that a third of the water-fall on a certain extent of land gives a certain flow; that another one-third evaporates and is taken off by the plants, and that the last third percolates to the lower strata. How far that is the case here is difficult to know because there are no observations taken.

Senator JONES. That is, one-third is taken up by the plants, one-third goes off in evaporation, and one-third percolates below?

Mr. VAN DIEST. Yes; that is the experience in London, England, and Paris, France, where considerable artesian water has been got. Similar observations have been made in India. Batavia is now supplied with artesian waters after surveys made by me. No observations are made here, and it is difficult to say what the case is. From the very sandy condition of a great deal of the outcropping rocks in the arable regions of Colorado, a good deal must percolate to great depths. That is proven to be the case in Denver, the Denver basin having ob-

servations made in it to some extent by Mr. Cross, of the Geological Survey. We came to the conclusion that there was considerable water running down to the lower strata. By borings that have been made since (about two hundred flowing wells having been bored) we have observed that there are three different flows. Speaking of those flows, I would say that the upper flows, to which many wells have been bored, are very limited. The lower flows take water from a greater extent of country. Much trouble has occurred in the artesian diggings by the bad construction of the tubing. There are a great many of such basins here all along the foot-hills, and it has been proven that there is much loss, as, for instance, in the San Luis Valley, where they have had flows of water to a great amount. I do not know exactly the figures, but very much more than is necessary for domestic use. There would be a chance to apply water for irrigation. The same is the case in the San Bernardino Valley, in California, where over two thousand artesian wells are aiding in irrigation. They are under regulations, so that during the night they must be closed off with stop-cocks. Thus, there is no unnecessary water flowing off. Similar arrangements can be made here.

I will call the attention of the committee to the great amount of water which flows away without our seeing it. There are many streams that run east of us here, such as the Bijo, the Badger, and other creeks, which at their best are all running streams and have considerable water. Over distances of 20 to 30 miles they are entirely sunk and lost. The Platte Valley is increased farther down in its flow. Without seeing it directly here, the volume of water in the Platte is increasing. It must be that the water from some of the mountains flows invisibly away, probably not at a very great depth. Perhaps at 15 or 20 feet deep there may be an impermeable layer and that it flows under the surface away. I think that that water could be made useful by pipes from a distance out, carrying the pipes to a place where the water is needed. Certainly a great deal of land could be redeemed by the percolation of water which is now lost.

The CHAIRMAN. Have there been any deep wells bored here?

Mr. VAN DIEST. The first flow in this neighborhood was got by boring to about 150 feet. The second flow to about 400 feet, and the deepest 700 feet. There may have been some wells bored deeper than that. One well, for example, has been bored to nearly 900 feet. That is the well that contains the iron water.

The CHAIRMAN. No deeper than 900 feet?

Mr. VAN DIEST. No; there is no doubt, according to the outcrop and the water from the mountain side, that there must be an overflow of water from the sandstone layers which are between the other strata under ground.

The CHAIRMAN. Have you observed the formation in the hills here, whether the strata is tilted up?

Mr. VAN DIEST. Yes; certainly. Near Golden the strata are nearly perpendicular. Where Cold Creek comes out the upper part of the formation crops out again as we see it at Golden. If there was not a great deal of friction in the sandstone layers which carry the water we would not get so much at the surface.

The CHAIRMAN. You think there must be a deep vein of water, probably?

Mr. VAN DIEST. I think so because the borings here have not reached the coal formation yet.

STATEMENT OF J. S. GREENE.

The CHAIRMAN. You have been State engineer here, have you?

Mr. GREENE. I was State engineer in 1887 and 1888.

The CHAIRMAN. You have heard the statements made here to-day, have you?

Mr. GREENE. Some of them.

The CHAIRMAN. Can you add anything to them or make any further statement with regard to your observations?

Mr. GREENE. I want to give a little note of warning to the committee. It may be overcautiousness, but I think I detect a tendency to place certain matters before the committee in a flattering light which I think will be to the disadvantage of the State later on. That is more especially in connection with the duty of water.

In speaking of the duty of water, it is often mentioned carelessly, and a distinction should be drawn between water measured at the cañons of streams used for irrigation below them. Sometimes we speak of the duty of water at the entrance of the ditch. At other times the duty of water is spoken of where it is carried and is immediately distributed to the land. There are people looking toward the conclusions of this committee who will base their actions upon what this committee probably shall report or in some way intimate as the duty of water. Already there has been published in our papers a statement to the effect that an acre foot of water was sufficient to irrigate 1 acre of land. That was stated to have come from the Director of the Geological Survey. I have no doubt that when that statement was made it was qualified. Possibly it was said that an acre foot of water could irrigate 1 acre of land, if there was rain-fall of say 8 or 9 inches during April, May, or June. Possibly it meant that it would be an acre foot of water just distributed on the land.

If the impression gets out, however, that an acre foot of water stored in reservoirs in the fall and winter months, to be taken out and put on the ground in the dry season is sufficient to irrigate an acre, the result will be that the people will undertake to build reservoirs and construct ditches and they will be failures. It will do more harm to the State than a more conservative position. I dread expensive failures in connection with irrigation works, and I think I see them coming and resulting from an overestimate of the duty of water. The duty of water that was given to you this morning of 346 acres per cubic foot per second is, as I say, an extremely high one. That water was measured at the cañons or outflow points of the streams. It was used over, many times, portions of it, and all of that land was not satisfactorily irrigated land.

Senator JONES. I think all that has come out in evidence.

Mr. GREENE. Statistics were taken from my report of last year and I know that very much of that land was not satisfactorily irrigated.

Senator JONES. State what you think the duty of water is here, measured when it goes on the land.

Mr. GREENE. I have in my report attempted to make an estimate of what it is within Colorado. It differs with the character of the land and the character of the soil and subsoil. It may run to 90 or 100 acres.

The CHAIRMAN. That is, 1 cubic foot per second?

Mr. GREENE. But that is some years ahead, I think. As a rule, we do not do that now. There is this to be taken into consideration:

Since this measurement of water at the cañons indicates that the water is used over and over again (because we know that water applied directly to the land will not irrigate any 346 acres or any 246 acres—none of us expect to go over 100; and, where the water is taken right on the land, I do not expect it to go over 80 or 90 acres), that indicates that the higher up on the streams these canals are taken out, the better it is for the State; that is, more land will be irrigated. So that with regard to the question as to whether the waters of the Colorado should be turned down into Kansas, I should think that if the benefit of the community was considered, it would appeal to the committee as desirable that this water should be used first near the cañons; then afterward, portions of the same water again and again, so that a greater good can be effected by using the entire water of the streams in Colorado than could be effected if portions of it were turned down.

Senator JONES. Than if portions of it were turned down to be used first in Kansas?

Mr. GREENE. Yes; to be used there first.

The CHAIRMAN. In taking the water on the land, has no method been adopted beside ordinary ditches? Do they use pipes?

Mr. GREENE. We have not irrigated much with pipes. We have done very little subirrigation.

The CHAIRMAN. I do not mean subirrigation, but to carry the water to the place to be used.

Mr. GREENE. We have done some of that.

The CHAIRMAN. Have they cemented the bottoms of the ditches?

Mr. GREENE. A cement is used in some cases.

The CHAIRMAN. That saves considerable of the seepage if you get the water to the land?

Mr. GREENE. The objection to pipes is that the friction is increased more, and it requires a greater hill than when the water is brought directly on the land. I am using a pipe now of long-leaved Texas pine, bound with long bands. It is used under the St. Charles River.

The CHAIRMAN. How do they irrigate here—by flooding the ground between the rows close together and running the water along in ditches?

Mr. GREENE. They have little ditches and frequently flood the ground.

The CHAIRMAN. Then, do they check it?

Mr. GREENE. It is checked—some of it—and prepared for flooding.

The CHAIRMAN. Which is regarded as the most economical way?

Mr. GREENE. To carry it in ditches in rows is considered the most economical. I believe the committee has had my report presented to them of statistics gathered during two years, and it contains the maps of Colorado. I do not know whether you have looked into our drainage system or not. My report also contains the figures of the capacity of our streams, so that we know how much water we have to distribute.

As to the matter of the segregation of land I do not know whether the committee is considering that subject or not. But I think it is highly proper that the land suitable for reservoirs should be segregated. The land that lies under the sites of proposed ditches should not be segregated, but it should soon be put upon the market again and be made open to homestead settlement, because otherwise it will delay irrigation development in Colorado.

Senator TELLER. It is not segregated now, under any fair construction of the statute, until the reservoir is first made, and then survey made to see what land will be irrigated from it. The statute provides that then that land shall be segregated.

Senator JONES. Is that with regard to the National Government?

Senator TELLER. Yes.

Senator JONES. I understood that the Commissioner of the General Land Office, on request of the Director of the Geological Survey, has the right to reserve for a limited time to give an opportunity for examination. If the Director of the Geological Survey has reason to believe that a certain locality would make a favorable reservoir site he requests the Commissioner of the General Land Office to reserve it.

Senator TELLER. He can do that without any statute.

Senator JONES. I thought that was provided for by statute.

The CHAIRMAN. That is a matter of administration.

Senator TELLER. And it is very proper.

Senator JONES. Certainly.

The CHAIRMAN. You regard it as important, Mr. Greene, that these surveys should be pushed rapidly?

Mr. GREENE. I do, indeed. I think these surveys are a great thing; more especially the determination of the precipitation both on the plains and in the mountains. It is from that we must eventually determine what lands can be irrigated. We know pretty well what amount of precipitation in the mountains is carried off through the cañons of the streams, but what proportion of that on the plains runs off we do not know.

Senator JONES. What amount of rain-fall do you think passes down through the cañons?

Mr. GREENE. My impression is that 40 per cent. of the aggregate rain-fall of the mountains passes down through the cañons.

Senator JONES. That is very much smaller than I supposed.

The following papers were received by the committee and ordered filed.

The committee then adjourned.

STATEMENT OF E. T. WILCOX, FIRST LIEUTENANT SIXTH CAVALRY, U. S. ARMY, FORT LEWIS.

I have seen the results of irrigation in certain portions of the West, and in different soils. My experience has been that all that is required on prairie, sage brush, or desert is water, to make the lands of the West productive of any cereal, vegetable, or fruit that the climate will admit of. In and around the town of Phœnix, Ariz., all grains and fruits, even tropical ones, flourish in great richness, the land before reclamation being simply an arid, rocky, and sandy cactus desert. The water is brought from the Salt River by two large canals, and thence distributed over the land by means of ditches, of greater or less size. Veritably, this desert is "blooming like the rose." This section has long been under irrigation. Long before the white man entered it the Pima and Maricopa Indians had made much of the land fertile and productive by irrigation, of which they have an excellent idea. All the country along the Verdi and Salt Rivers is now under cultivation, with rich results, due to irrigation. This much for purely desert lands. Upon the prairie and sage brush country let us take Salt Lake as an example: Not many years ago it was a parched, sage brush wilderness; now it is a garden and a mine of agricultural wealth, all due to irrigation from the waters of the Jordan, and the fresh-water lake 50 miles away. These two examples cover the two kinds of country in the West.

My experience has always been that the soil is ever abundantly productive, and all that is required is water, and if water is at hand, little science is required to carry it over the arid land. In many of the arid valleys of our western country underground rivers run, the waters of which may be brought to the surface by means of wind-mills, hot-air engines, or sunken pipes. As an example of the latter, I note "Soldiers' Holes," or Sanderson's ranch, in the valley of the Sulphur Spring, Arizona, a large arid prairie valley. When I first saw it, in 1878, a miserable little well gave water to a small cow-boy bar-room at "Soldiers' Holes;" when I again chanced there, in 1883, I found a flourishing ranch, two large lakes of water below the houses, hundreds of cattle, horses, etc.; Sanderson, a rich and prosperous man. He told me that he had just been offered $150,000 for his place. All this was simply produced by sinking

5-inch iron pipes in the ground, striking, as I believe, the underground current of the lost Santa Cruz River, from 30 to 45 feet below, the water bubbling out of the pipes 6 inches above the surface, and then running off and forming its own reservoir—"the twin lakes." Sanderson was induced to sink these pipes by the offer of the Arizona legislature of $10,000 for the first artesian water found in the Territory.

A plan, once proposed by General J. C. Fremont, I believe, seems to me worthy of consideration by Congress for the benefit of our extreme southwestern country, Arizona, etc.; that is, to form of the great Colorado desert, which is in most part below the level of the sea, a great inland sea or lake, by one of two methods, *i. e.*, either by letting the water of the Gulf of California into it, by canals, or by flowing the waters of the Colorado and Gila rivers into the desert, letting them find their own outlet to the Gulf. The desert is now a useless, intensely hot, arid alkali waste and will never be anything else. By making it a sea or lake the whole climate of that section would be changed; rains would come, and the land would produce and grow in fruitfulness for the benefit of our ever-growing and great people. All our Western soil is rich, water on its bosom will make it fruitful.

STATEMENT OF N. S. JARVIS, FIRST LIEUTENANT AND ASSISTANT SURGEON, U. S. ARMY, OF FORT LEWIS.

My limited service has carried me over a portion of Arizona, in which irrigation on an extensive scale will accomplish wonders. An instance coming under my observation proves this: At a point 60 miles to the southwest of the confluence of the Great and Little Colorado Rivers is a small Mormon town, called "Tuba City." This lies on the edge of an arid region, known as the "Great Painted Desert." By collecting the water of several small springs into reservoirs and thence distributing over a few dozen acres the most remarkable success has repaid the efforts of the inhabitants. They raise corn, wheat, a variety of vegetables and fruits and even cane sugar.

This indicates to a certain extent the bearing capacity of this now desert and weird region. The Indians in this country raise millions of sheep. General Greely, in his recent interesting report to the Senate on the rain-fall of certain portions of the West, states that land in the San Joaquin Valley capable of raising grass sufficient to support one sheep, under the influence of moisture permitting the growth of alfalfa will nourish 20 sheep to the acre.

Thus can be imagined the enormous number of these animals, outside of farm products, that could be raised in the country of which I speak if the soil were allowed the benefit of abundant moisture.

STATEMENT OF S. BAKER, CAPTAIN, SIXTH INFANTRY, U. S. ARMY, OF FORT LEWIS.

During the last eighteen years I have observed wherever irrigation was practiced in western Kansas, western Dakota, Montana, Idaho, Wyoming, Utah, and Colorado large yields and sure crops were the result. Every acre of soil in that region, if cultivated by irrigation, will produce any crop in abundance that the climate will permit. Without irrigation farming is practically out of the question in the whole territory mentioned. These remarks apply to Nevada, Arizona, and New Mexico also. The question is, how shall all available arid land be irrigated and reclaimed?

The land on each side of an ordinary stream can be irrigated from the stream to the extent of its water capacity. In the valleys of the larger rivers water can be taken out at any season of the year sufficient to cultivate a large portion if not the whole valley while the river is in the mountain district. I am speaking of such rivers as the Yellowstone, Madison, Gallatin, and Jefferson in Montana; the Snake and Bear in Idaho; the Green, Grand, Arkansas, and other large rivers in Wyoming and Colorado.

The tributaries of these streams run comparatively short distances through extensive valleys and have rapid currents, which, in the season of rains and melting snows in early spring, increase to torrents, in which water is carried off that is absolutely necessary later in the season for the production of crops. Speaking in a general way, it would seem that all that can be done is to save as much of this annually wasted water as possible, and the only way of doing this that presents itself is by means of dams, making lakes at such points as the conformation of the adjacent country will permit with the least damage.

Of course these lakes or reservoirs must be near the heads of streams, and, as all the large rivers have numbers of tributaries, and as each tributary would have its system of reservoir lakes, the storage capacity in the mountains would seem to be quite enough to supply sufficient water for irrigation at pleasure, not only along the whole course of the tributaries, but also in the main stream, if some directing authority like, for instance, the Interior Department, had supreme control over the whole system.

Wherever water is scarce during the growing season a supply must be stored during the previous abundance and kept until it is needed. That it can be stored near the sources of streams and rivers by artificial lakes there can be no doubt. Take, for instance, Snake River, in Idaho. At the head of North Fork there is a basin that was formerly a lake, covering an area of several hundred square miles, the outlet of which runs through a narrow gorge that could easily be dammed at many places, which would create an inland sea where there is now nothing but an enlargement of the river, called Henry's Lake, at the foot of Tahgee, Raynolds, and Red Rock Passes.

Again, at the head of Pierre's River, a branch of the Snake, having its source in the Teton, there is a basin of from 12 to 15 miles square, whose outlet runs through a narrow gorge made in the porphyry rim of the basin, which could be easily dammed, producing a lake of magnificent proportions considered as a reservoir. South fork of Snake runs through another basin east of the Teton, and then gorges, but this eastern basin has a number of quite large lakes already, which supply the main Snake with plenty of water.

I give this as an illustration of the system proposed, not that it is necessary in this case, as I believe there is water enough in Snake River to irrigate its whole valley. Of course such a system involves great expense, but the question of supplying water for irrigation is as important to the country west of the Mississippi Valley as the improvement of river navigation is to the rest of the country.

STATEMENT OF O. B. WARWICK, FIRST LIEUTENANT, EIGHTEENTH INFANTRY, U. S. ARMY, OF FORT LYON.

In reference to the subject of irrigation I can only testify to the satisfactory results obtained from land that has been irrigated. The only land that I have observed was irrigated from ditches taken out of streams. From the general slope of country I have no doubt that many thousand acres of land, now worthless, could be made productive by means of large storage-reservoirs. Irrigation has certainly proved a great benefit to this State and in Montana, where I was previously stationed. Many thousand acres of arid land in Colorado and New Mexico, I think, could be made productive by means of storage-reservoirs, that would be of incalculable value. To accomplish this the cost would be great, but the results obtained would more than compensate for the outlay of money. Cereals and vegetables are now grown near this post on land that two years ago was not productive. The subject is one that I consider of great importance, though I lack the experience to be able to give as satisfactory data as I would like.

STATEMENT OF JOHN S. GRISWOLD, SECOND LIEUTENANT, THIRTEENTH INFANTRY, U. S. ARMY, OF FORT LYON.

The soil of eastern Colorado will produce nothing without irrigation; but where irrigation has been resorted to the results have been entirely satisfactory. This was well demonstrated by the products exhibited at the Colorado State fair, held at Pueblo last October. The inhabitants are unanimously of the opinion that were Colorado well watered it would rival in its products those of Indiana, Illinois, or any other Central or Eastern State. The slope of the country from the mountains in the west and center toward the east would greatly facilitate irrigation. Canals and ditches could be dug, thus opening up thousands of acres to cultivation, the canals being fed by the Arkansas and the mountain streams. It would also be possible to build large central basins. The construction of canals, facilitated by the lay of the country, would be accomplished at comparatively small expense and would be of inestimable value to Colorado.

STATEMENT OF F. E. LACEY, CAPTAIN, TENTH, INFANTRY, U. S. ARMY, OF FORT CRAWFORD.

The system of irrigation in use in this valley does not differ from any I have seen in other parts of the country, and seems to be fairly well adapted to present wants. There seems to me to be an unnecessary waste of water, owing to the fact that there is no proper means of regulating the flow of surplus water when the river is high; consequently in the months of July and August there is a great scarcity of water and late crops suffer. Storage-reservoirs could, with small expense compared with the results, be constructed in the foot-hills on both sides of the Uncompahgre River. There are many natural depressions admirably suited to that purpose and much valuable land now almost barren would become good farming land. I believe a system of reservoirs in the Arkansas Valley will soon be an absolute necessity.

STATEMENT OF WALTER D. McCAW, FIRST LIEUTENANT AND ASSISTANT SURGEON, OF FORT CRAWFORD.

My experience on the subject of irrigation is limited to the most casual observation of the method pursued in this valley, gained from a year's stay at this post. The land here can hardly be called "arid," as the soil seems to contain everything necessary to the growth of nearly all grains, fruits, and vegetables, which will grow in a temperate climate. There is, however, a deficiency of rain-fall usually from May to August or September, and irrigation is practiced to make up for the small amount of rain. The method used is the simplest known. The water is taken directly from natural water-courses, no reservoirs being known, and is conducted to the highest level of the land to be cultivated; there it is caused to overflow the ditch, by the action of small wooden sluice-gates placed at convenient intervals. If the land is planted with vegetables, in hills, the water overflows in a series of small channels perpendicular to the conducting ditch and running between the hills; fields of grass, alfalfa, or grain are simply flooded. The water not taken up by the ground is collected in a ditch placed at the lowest level of the ground, and thus conducted away. Irrigation is practiced from April to the maturing of the crop. No manuring effect is expected of the water, but simply the moisture is needed in the absence of rain. The ditch company in this valley sell the right to water from their ditch for $10 an acre.

That land perfectly arid, without vegetation, may by the constant use of water be rendered fertile, is, I believe, undoubted. In such cases the manuring effect of water, and not moisture alone, is needed, and a long time might be required in effecting the change. The circumstances would be very different from those in this valley. The quality and amount of suspended matter of the water, the climate and soil of the land to be irrigated, would all have to be carefully considered. I am not prepared either by experience or acquirements to offer any views of practical value on the subject of "irrigation of arid lands."

STATEMENT OF THOMAS McCUNNIFF, INDIAN AGENT, OF SOUTHERN UTE AGENCY, IGNACIO.

All facts and data bearing upon the previous customs of irrigation practiced by the Indians under my charge are very meager and unsatisfactory. In fact, in former years, the Utes seem to have relied but little upon the products of the soil. Their efforts were confined to the raising of small patches of corn and melons, which were always planted at the mouth of some vega, where the water from above filtered through the soil and moistened the roots of the plants. From this practice, we may infer, we have the present system of subirrigation. But, owing to the increased numbers desiring to engage in the raising of crops on such small patches and the limited amount of available land under that primitive system of irrigation, it became necessary to devise some means by which a larger area could be utilized. This probably caused the Utes to resort to the system of irrigating ditches, with flumes and headgates, which is now practiced here and in the main throughout Colorado and New Mexico.

STATEMENT OF WILLIAM ASHTON, ENGINEER, COLORADO DIVISION, UNION PACIFIC RAILWAY COMPANY, DENVER.

Along the Kansas Pacific Division of the Union Pacific Railway, which passes through the central eastern portion of the State, water for the various uses of the railway company is obtained from wells; these wells are in most cases sunk at a point near a small water course, and although the water seldom appears as a stream in these water-courses, a fair supply as to quantity is usually obtained by sinking wells through the sand and gravel beneath the bed of these apparently dry streams

At one point on this line of railway an artesian well has been put down which I understand is furnishing a large amount of very good water; of this you probably have record in your office. This well is about 15 miles west of the east boundary line of the State and nearly midway between the north and south boundaries.

The Julesburg branch, owned and operated by this company, lies along the South Platte River from the point where it enters the northeast corner of the State to its junction with the Denver Pacific district at La Salle. Plenty of water for our purposes can be obtained at almost any point along this line by sinking a well from 20 to 40 feet deep; quicksand is often struck in these wells and the water contains some alkali.

Wells along this line are located as below and of dimensions shown.

Station.	Depth.	Diameter.	Quantity.	Quality.
	Feet.	*Feet.*		
Sedgwick	21	11	Plenty....	Some alkali.
Crook	20	11	....do	Do.
Iliff	21	11	....do	Do.
Sterling	22	12	....do	Do.
Merino	21	11	....do	Do.
Snyder	20	11	....do	Do.
Deuel	22	11	....do	Do.
Orchard	20	11	....do	Do.
Hardin	20	11	....do	Do.

On the Denver Pacific district water was more difficult to find. At Pierce a well 34 feet deep supplies all water needed for locomotives and station purposes, while 10 miles farther north, at Dover, a hole was put down 175 feet and no water found.

At Athol, on the divide between Lone Tree and Crow Creeks, a well was sunk 162 feet, but no water found. Athol Station is very near the north boundary line of the State.

On the mountain districts plenty of water for railway purposes can usually be taken from streams along the line or from adjacent springs. Most of the water-tanks on these districts are supplied by gravity pipe lines and the quality of water is usually good.

Dug wells in eastern Colorado cost us from $10 to $15 per foot of depth for wells 10 to 15 feet in diameter and less than 80 feet deep. This price covers the well complete, well lined with a good dry stone wall for its entire depth. Quicksand is usually overcome by walling the well as fast as it is sunk and by cementing the wall where unusually bad strata of quick sand are found.

On the Denver Pacific district, between Denver and Cheyenne, we have for the supply of locomotives five wells, including one at Denver, and, in addition to this, one tank at Carr, supplied from a spring.

These wells are as follows:

Station.	Depth.	Diameter.	Quantity.	Quality.
	Feet.	*Feet.*		
Denver	25	20	Abundant	Alkali.
Brighton	32	6	Plenty....	Fair for locomotive use.
Plattevillo	31	12	.....	Alkali.
La Salle	.....	.....	.....	
Pierce	31	12½	.....	Fair for locomotive use.
Carr	11	9	.....	Do.

On the line of the Colorado Central we obtained all water from the water-works of the towns we pass through; this water is usually from a mountain stream by a gravity pipe line; the quality of water is good.

On the Denver and Boulder Valley from Brighton to Boulder we have no water stations; water could be obtained at almost any station along this road by sinking a shallow well, except where road crosses the divide between South Platte River and Coal Creek.

The water in this section of the country contains a large amount of alkali if taken from near the surface.

On the Greeley, Salt Lake and Pacific district the only water station is at Fort Collins; this supply is from the city water-works.

At Stout a pipe line is laid from a spring in the side of a steep hog-back from which water of good quality is obtained, but the amount is so limited that it is seldom used for other than domestic purposes.

The Denver, South Park and Pacific district as well as the other mountain lines, is well supplied with water; most of it of good quality, from mountain streams.

No water-storage system used by this company in Colorado.

The headquarters of the engineering department for Colorado being at Denver, the location of a United States observation and weather reporting station, no accurate record of temperatures, precipitations, etc., has been kept.

The use of artesian wells in and about Denver has greatly increased within the past three or four years, and this method of obtaining water for domestic use has been largely adopted both in the city and country. The section about Denver in which

these wells flow is described about as follows: From Golden north to the south line of township 1 south; thence northwest to Brighton; thence east to near the divide between the South Platte River and Box Elder Creek; thence southerly along said divide to the south line of township 4 south; thence southwest to Acequia and Platte Cañon; thence north along base of mountain to Golden. There are points outside and adjacent to this district where flowing wells are struck, but as near as I can determine at present the district as described is practically correct.

Artesian wells seem to be a success over the entire eastern portion of Colorado, a good supply of good water usually being found, but at some points it is so far below the surface that the expense necessary for pumping machinery decreases the value of the well. These wells, so far as I know, are used for domestic purposes except in a few cases where the overflow is retained in a small reservoir for irrigating purposes, but these cases are so rare and the reservoirs so small that they practically have no bearing upon the irrigation problem.

Water that rises to the surface is found in the vicinity of Denver at a depth of about 325 feet and 600 feet; the best wells are from the 600-foot flow.

From the 600-foot flow a pressure of 20 pounds per square inch at the surface is often obtained, while it is claimed by many that some wells have a much higher pressure.

That portion of Colorado east of the base of the mountains could be almost entirely utilized as farming land and for agricultural purposes if water for irrigating could be obtained. The soil is light, and in many cases contains a considerable amount of sand, but when properly irrigated the crops grown in this soil are seldom surpassed. Farming has been attempted in the extreme eastern portion of the State at several points without irrigation, but although partial crops have been raised—and some of the farmers by this method are very confident of success—the future will probably prove that even in the most eastern portions of the State this method will prove very uncertain and unsatisfactory.

BLANKS AND FORMS USED IN DITCH MANAGEMENT.

[Furnished the committee through S. J. Gilmore by the Northern Colorado Irrigation Company, office, Denver, Colo.]

RULES FOR EMPLOYÉS ON THE PLATTE CANAL.

D. W. Payne, division superintendent.
Division No. 1.
This division of the canal commences at ——— ——— and ends at ——— ———.

You are specially under the orders and directions of the engineer, and you are to carry out faithfully and promptly all his instructions. You will frequently and closely examine every part of the canal in your division, and enter in your weekly report any remarks that you may think necessary regarding the general condition of the works. Should there be a necessity for immediate attention to any part of the canal, report immediately on the telephone to the office, or if before 9 o'clock a. m. or after 4 o'clock p. m. ring the number on the telephone for the engineer. Failing to get an answer from the engineer ring the manager's number.

Should a serious leak, or break, or overflow occur, you will immediately make every effort to stop it, and to accomplish this you may hire such assistance as may be necessary and close at hand. Open the nearest waste gates above the leak, or break, or overflow, and if necessary to have all the water shut out of the canal, telephone to Denver to any of the three calls there. Should the accident be one that you can overcome without great difficulty, do not lose time by leaving it and trying to telephone, but get such assistance as may be nearest. If necessary, send or go to the nearest telephone and give notice to the engineer.

All employés on the canal are required to promptly render assistance to each other whenever there is any necessity for so doing. Each division superintendent shall keep a daily record of the depth of water on the gauge or gauges in his division, and will report the same to the engineer by telephone daily.

Each division superintendent shall provide himself with a suitable horse and cart, if such conveyance be required, and shall at all times carry with him a shovel, hammer, nails, screw-driver, wrench, measuring rule, and telephone tools, all of which, except the horse and cart, and feed for horse, will be provided by the company. In addition to these tools, there should be on each division oakum and sacks, and division superintendents will promptly notify the engineer when additional supplies are needed.

Expenses.—Except in cases of emergency, such as leaks, breaks, or overflows, or danger of any of these, no materials or tools shall be purchased or obtained on the credit of the company, except by the engineer or on his order, and no labor shall be

employed except in emergencies as above stated, without first having the authority of the engineer. In all cases where laborers or mechanics are employed, the person in charge of the division where the work is being done shall keep a full and complete record of the time each person is employed and the wages to be paid, unless the engineer shall place some other person in charge of the work.

All payments for wages or hire of any kind and for material, shall be made at the office of the company in Denver, and then only upon properly stated and certified accounts first approved by the president or manager.

Care of property.—All property of the company must be carefully watched and protected on each division by the division superintendent, and he shall be responsible for locks, keys, gate-pins, tools, bolts, bars, or other effects. He shall report promptly to the engineer or manager all cases where the property of the company has in any way been tampered with or damaged, such as the cutting or breaking of gates or weirs, or interference in any way with the banks of the canal or flumes. He shall also report all cases where any damage has resulted to the property of others by reason of overflow or breaks, or in any other way.

Distribution of water.—Such water as may from time to time be in the canal shall be divided pro rata to all persons entitled thereto by reason of their ownership of water rights, and each person in charge of a division shall in the most impartial and careful manner turn water out of their respective gates in strict accordance with the directions given from time to time by the engineer or from the manager's office, and under no circumstances is any person to be allowed to open a gate or in any way to obtain more water than the quantity stated in the directions. The gate on every outlet must at all times be kept locked and the division superintendent must at all times carry the keys with him. He shall carefully inspect all gates, weirs, and outlets every day to see if all be in good order, also to discover if the gates are being tampered with, and he shall measure and record every day the depth of water flowing over each weir, and enter the same in the reports prepared for such purpose. Look sharply for persons having duplicate keys.

All outlets are to be kept free and clear of drift-wood and all other floating matter, and the gates should be frequently examined to see if there be a free flow under them; also that no wedges have been driven under them by persons trying to get more water.

Do not accept the statement of any person about water; all instructions pertaining thereto will be given on the telephone, or in writing, from the proper authority.

Report promptly the name of any person who offers any bribe or any inducement to get more water than is then being allowed under the directions given you.

Whenever there is a rise in the water in the canal, not caused by floods from the prairie, the quantity running over the weirs in the lateral ditches should not be allowed to increase by reason of the greater pressure on the outlets. The gates in the outlets should be partly closed down so as to give just the same depth of water over the weirs as was running before the rise, unless orders contrary to this have been given from proper authority. In almost every instance when more water is taken into the canal from the river, the extra quantity is intended for the divisions at the end of the canal. When a suddenly great rise occurs in the canal by reason of flood water from the prairies, caused by a storm, make haste to the waste-gates and open them, also let out at all the outlets in the canal as much water as the lateral ditches will fairly carry without overflowing or doing any damage.

Whenever there are indications of a storm and a flood, the waste-gates should be opened before the flood comes. Good judgment and prompt action in emergencies of this kind will determine the efficiency and earnestness of the employé in the duties assigned to him.

Whenever you see that water is being allowed to run to waste by any irrigator, reduce the quantity running over the weir to the extent of such waste. If you see that a lateral ditch is broken, and the water is running to waste, shut off the water and notify the superintendent of the lateral or some person who is using water from it. Make a record of your action in every case of the two above kinds, and state the particulars in your weekly report.

NOTE.—There must not be any absence from duty unless permission first be obtained from the engineer or manager.

There must not be any scolding with, or rough language applied to, farmers or users of water. You can perform your duty better without this. If any one assaults you without just provocation the company will assist you in a prosecution.

Any case of intoxication or any neglect of duty, or apparent indolence or indifference on the part of an employé will be met with prompt dismissal.

All reports must be carefully and accurately made, so that, if necessary, they can be sworn to.

S. J. GILMORE, *Manager.*
GEORGE G. ANDERSON, *Engineer.*

THE NORTHERN COLORADO IRRIGATION COMPANY.

Record of depths of Water at the weir, at the city limits of Denver, for the week ending Saturday, ———, 188—, *at* 6 *o'clock p. m.*

Day.	7 a. m., depth in inches.	6 p. m., depth in inches.	Average depth per day.	Discharge in cubic feet.	Total quantity in gallons.	
Sunday						
Monday						
Tuesday						
Wednesday						
Thursday						
Friday						
Saturday						

I certify that the depths of water entered above in the first two columns are true and correct.

——— ———.

I certify that the depths given above in the first two columns and the average depths given in the third column show a total delivery of water for the week ending as above, of —— cubic feet, or the equivalent of —— gallons.

——— ———,
——— ———.

Record of depth of water on weirs in third division for the week ending Saturday, September 16, 1888.

Outlet number.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
47	No water in the ditch.	Do.	Do.	Do.	Do.	Do.	Do.
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							
58							
59							
60							
61							
62							
63							
64							
65							
66							
67							
68							
69							
70							
71							
72							
73							
74							
75							
76							
77							
78							

I certify that the depths of water entered above are true and correct.

THOS. EVANS,
Division Superintendent.

Record of depths of water in flumes, etc., for the week ending Saturday, ——— 18—.

Location.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
Dam.....							
Cañon Flume....							
Plum Creek							
Bennett Gulch...							
Little Dry							
Cherry Creek....							
Section 1 Check .							
Dryer's Check...							

I certify that the depths of water entered above are as telephoned to me daily by the respective division men.

——— ———,
——— ———.

Report of services performed during week ending Saturday evening, ———, 18—, *by* ——— ———.

Sunday,

Monday,

Tuesday,

Wednesday,

Thursday,

Friday,

Saturday,

The Northern Colorado Irrigation Company. Report of services performed by ——— ———, for week ending Saturday evening, ———, 18—.

[Fill in every evening, and not wait to end of week, when you may have forgotten particulars.]

NOTE.—This report may be made in pencil. It need not include all the little details of work, but should be sufficiently full to clearly indicate what was done each day. It should be sent by mail, or otherwise, at the first opportunity, to—

S. J. GILMORE,
Manager, Denver, Colo.

STATEMENT OF A. J. McCUNE, CIVIL ENGINEER, GRAND JUNCTION.

[The statements from western Colorado were received after adjournment and ordered inserted in report.]

I am a civil engineer, and have resided here since 1883. I was engineer on the Grand River Ditch during its construction and for two years past have surveyed several sites for small reservoirs for the farmers. As to the extent of our system: The Grand Valley Canal is in width 35 feet in the bottom, to run 5 feet depth of water. It covers 40,000 acres; cost about $250,000. There are about seventy-five small irrigating ditches, covering, perhaps, 60,000 acres. The Grand Valley Canal is taken from the Grand River; the smaller ditches are taken from the tributaries of the Grand River.

The supply of water from the Grand River appears to be sufficient for all land that it is practicable to water from that river. The supply from the smaller streams is limited, except for a period of two months, or perhaps seventy days, while the snow is melting from the mountains.

There is need of storage reservoirs on the southern and western slopes of the Grand Mesa. In the valley of Kannah Creek and Whitewater streams there is a large body of valuable fruit and farming land, perhaps 40,000 acres, that could be successfully watered from reservoirs upon the Grand Mesa.

There are some old lake beds on Grand Mesa that could be successfully converted into reservoirs.

A full survey for irrigating purposes would be helpful in promotingthe co-operation of capital and in constructing storage works.

The farmers have already done something in a very small way, but their means are too limited.

If a survey were made pointing out the location of reservoirs and the feasibility of making by the building of reservoirs thousands of acres of land now worthless to be worth from $25 to $50 per acre, capital could surely be induced to construct such works. There are other portions of this country where the small streams have been overtaxed, in other words, where more land has been entered than could be watered, through ignorance on the part of the farmers, as to the capacity of the streams. At the head of these streams are good reservoir sites where water could be stored, not only to relieve the farms that are already located, but also to supply new ones. Altogether in Mesa County alone about 100,000 acres could be reclaimed.

STATEMENT OF R. W. SHROPHIRE, OF WHITE WATER.

I have been farming in Mesa County, Colo., since 1882. I live about 8 miles from Grand Junction. The results, financially and otherwise, have been beyond my expectations in every respect, both in farming and fruit raising. The chief products are timothy, alfalfa, and fruit. Irrigation does pay; I would not farm in a country where irrigation is not possible. My land, before cultivation under irrigation, was worth nothing. I have since been offered $6,000 cash for my 130 acres. This was days since. I have a house on it worth $1,500, but $8,000 cash is my price. I am cultivating 120 acres. My net profit last year was $2,000 on 80 acres. I had 40 acres rented. My water for irrigation comes from Kannah Creek and I have a plentiful supply, because the private ditch in which I have an interest has the priority of right to the water in the creek. There are 5,000 acres of land taken up and only half farmed, because of the fact that their rights are second to ours. Our ditch covers 1,000 acres.

There is a good location for a storage reservoir on that creek, and its establishment would be of benefit to the farmers now located in that section. It could be built on the Grand Mesa at a cost of $10,000. That would benefit the farmers now located on Whitewater, Kannah Creek, and the country between the two, to the extent of fully $10,000 in one year, besides enabling 10,000 acres more of land equally as good as that now farmed to be settled upon and worked with profit. We are short of water for two months, from July 15 to September 15, just the time when it is most needed. Our irrigating season is, for grain, five months; for fruit, eight months.

STATEMENT OF C. W. STEELE, OF GRAND JUNCTION.

I have been farming in Mesa County, Colo., since 1881. The results have been satisfactory in every respect. Our chief products are vegetables and small fruits. Irrigation pays and I would not farm, unless so situated that I could irrigate the land at will. My land before cultivation under irrigation was practically worth nothing. Its market value is for 35 acres, in cultivated fields, $50 per acre; for 35 acres an orchard, $200 per acre. I am cultivating 70 acres. My net profit per acre last year was for vegetables grown between trees in orchard, $50; alfalfa, $30 per acre. I own a water-right in perpetuity, paying an annual assessment of 20 cents per inch, equal to 12½ cents per acre, and have had plentiful supply at all seasons for eight years past. The water is taken from Grand River.

The possibilities for fruit raising in this section are great. I have lived in southwestern Missouri, and I find Grand Valley, Colorado, far superior. The fruit grows to greater perfection. It is not troubled with insect pests, such as codling moths, curculio, and the borer. Grand Valley is also adapted to a wider range of varieties. Grapes and gooseberries, which often scald or mildew in southwestern Missouri, succeed admirably here, as also do currants. My pears have begun fruiting, and in size and quality they compare favorably with California productions; trees show no symptoms of the dreaded pear blight. All peach trees of sufficient age were loaded with fruit the past season. The length of our irrigating season is nine months. The climate is hot and dry; the thermometer seldom reaches zero. The rain-fall is very little; not enough to be of any practical benefit, and there is scarcely any snow.

STATEMENT OF CYRUS L. HUGHES, OF DENVER.

I am a nurseryman, and my interests consist of an 80-acre peach orchard, three years old, 9 miles from Grand Junction. There are fourteen thousand trees in it, all in healthy condition. They will be in bearing next year. Have every reason to expect a yield of $15,000 worth of peaches from the crop of 1890. In this enterprise I have invested $11,000. The value of my land if I had no water would be practically nothing. I consider my 80-acre farm to be worth to-day at least $25,000.

STATEMENT OF J. CLAYTON NICHOLS, OF GRAND JUNCTION.

I devote my entire attention to alfalfa and stock raising and have 325 acres planted to alfalfa, 6 miles from Grand Junction. The yield of alfalfa thereon is 3 tons to the acre. It is worth this year $9 per ton on the ground. The land would not grow grass before irrigation, and was quite worthless. It is now worth $50 per acre. I get water from the Grand River Ditch. I have a quarter-section of land on "The Big Salt Wash," but prior rights take all of the water from me. Were a reservoir constructed at the head of this mountain stream, 5,000 acres would at once be available for farming purposes. My neighbors raise the finest peaches grown in this valley.

STATEMENT OF A. D. MAHANY, OF FRUITA.

I have farmed by irrigation 12 miles from Grand Junction for the past five years. I would not farm where irrigation was not possible. My principal crops are oats, wheat, corn, alfalfa, and fruit. I cultivate about 100 acres. There is plenty of water, except a little short in July. The water is obtained from the Grand River Ditch. Reservoirs could be built that would benefit the land. Above the line of the present ditch there is a fine country, which comprises about 5,000 acres, that could be economically watered were reservoirs built in what are known as the "Little Salt Wash" and "the Big Salt Wash," which have ravines carrying a large amount of water in the spring.

FORT COLLINS, COLO., *September* 17, 1889.

The committee met pursuant to call of the chairman.

Present, Mr. Stewart (chairman) and Mr. Jones, of Arkansas; also Director Powell.

STATEMENT OF N. C. ALFORD, OF FORT COLLINS.

The CHAIRMAN. What is your occupation?

Mr. ALFORD. Farming, mostly.

The CHAIRMAN. Where are you farming?

Mr. ALFORD. North of the town of Fort Collins; on the north side of the Poudre River.

The CHAIRMAN. I am told that you have had some experience as to the duty of water in this vicinity. Please state as to that.

Mr. ALFORD. As to the amount of water?

The CHAIRMAN. As to the amount of water necessary to produce crops, and the kind of crops that can be produced here.

Mr. ALFORD. For the first irrigation, we think it requires about 15 inches of water, covering the ground. The second time about 12 inches is required to raise a crop.

Senator JONES. Do you mean 15 inches the first year?

Mr. ALFORD. Yes.

Senator JONES. And 12 inches the second year?

Mr. ALFORD. Yes. Thereafter about 8 inches of water will raise a grain crop in ordinary seasons.

The CHAIRMAN. What amount is required to raise all-around crops, vegetables, etc.?

Mr. ALFORD. They require more. I never had any experience with vegetables.

Senator JONES. You mean 8 inches in addition to the rain-fall?

Mr. ALFORD. Yes.

The CHAIRMAN. Do you know how much rain-fall you have here?

Mr. ALFORD. I think about 15 inches, year after year, in a term of seven or ten years.

Senator JONES. How much in the irrigating season?

Mr. ALFORD. Our rain falls largely in the spring. If we have rain it is generally at that season.

The CHAIRMAN. In the irrigating season?

Mr. ALFORD. Yes, and prior to that time—in May, perhaps.

The CHAIRMAN. I see in passing through this country that people seem to have given some attention to storing water in reservoirs. Have you given any attention to that subject?

Mr. ALFORD. Yes.

The CHAIRMAN. With what success?

Mr. ALFORD. With very good success.

The CHAIRMAN. What is the method of doing it?

Mr. ALFORD. A ditch company of which I was president built one reservoir on the mountains that covered about 200 acres.

The CHAIRMAN. How deep was it, what did it cost, and what purpose did it subserve?

Mr. ALFORD. We now hold 20 feet of water in it, and we use it after the flood-time, if we do not have water sufficient for the ditch. The ditch it is connected with is one of the State appropriations and it was necessary to have water to carry out the irrigation system, because the prior rights took the water away from us on the river. We built that dam and reservoir on the mountains to supply the ditch at the times when the other ditches required all the water in the river.

The CHAIRMAN. And when they did not require it, you took the surplus and filled your reservoir?

Mr. ALFORD. Yes, we were allowed to take that when there was a surplus.

The CHAIRMAN. Is the surplus of this stream, the Caché La Poudre, all saved now, or does it go down stream?

Mr. ALFORD. There is a large surplus yet remaining.

The CHAIRMAN. A large surplus to supply other reservoirs?

Mr. ALFORD. Yes.

Senator JONES. How much did that reservoir cost?

Mr. ALFORD. About $15,000.

Senator JONES. It is 200 acres in extent?

Mr. ALFORD. Yes.

Senator JONES. And 20 feet deep?

Mr. ALFORD. We hold 20 feet of water in it now.

Senator JONES. Is that its capacity?

Mr. ALFORD. Yes.

Senator JONES. How far away is that from your line of ditch?

Mr. ALFORD. Seventy miles.

Senator JONES. You get it to your ditch by another ditch?

Mr. ALFORD. No; the law gives us a right to use the channel of the river to conduct water in.

Senator JONES. And you take the water from your reservoir by the channel of the river to that ditch?

Mr. ALFORD. Yes.

Senator JONES. So you were not at any great expense in constructing a ditch to carry the water from your ditch?

Mr. ALFORD. No, sir.

Senator JONES. You only use that to supplement your other ditch at such time when you do not get your ditch supplied from the river?

Mr. ALFORD. That is all.

The CHAIRMAN. You stated that there was a large amount of water still running to waste that might be stored in reservoirs. Is there land cultivated upon which to use that water?

Mr. ALFORD. Plenty.

The CHAIRMAN. Are you familiar with the country below here with reference to the opportunities to make reservoirs?

Mr. ALFORD. Yes; all the way to the Missouri River.

The CHAIRMAN. What do you say of the opportunity to store water?

Mr. ALFORD. There is an amount sufficient for more water than I think can ever be stored.

The CHAIRMAN. I know that, but what is the opportunity for storing water. They are not storing water away below here, are they?

Mr. ALFORD. I am not able to say; I do not think they are.

The CHAIRMAN. We have had some testimony all along the State with reference to water accumulating in the streams below after you have taken out all you wanted. Is that true of the Caché la Poudre? Do you find the water again in the streams from seepage or underground channels or anything of that kind?

Mr. ALFORD. It appears so in this river.

The CHAIRMAN. How far down is the lowest ditch taken?

Mr. ALFORD. In this stream, it runs into the Platte at Greeley. If I recollect correctly, Mr. Nettleton says there are 80 feet of seepage there.

The CHAIRMAN. Have you ever paid any attention to storing the storm water on ravines where there is considerable water shed, and without any running stream in dry weather?

Mr. ALFORD. I have had no occasion to look at that.

The CHAIRMAN. The water of the stream has answered your purpose so far?

Mr. ALFORD. We sometimes take it out into a depression or lake and store it and then take it out lower in another ditch.

The CHAIRMAN. That is, the water of the river.

Mr. ALFORD. Yes.

The CHAIRMAN. Can you estimate the amount that goes to waste in this river?

Mr. ALFORD. I can not say exactly. I have no way of knowing; some years we use quite a large proportion of it, and in other years I do not think that we use a tenth part of it.

Senator JONES. During the irrigating season, do you take it all out of the river?

Mr. ALFORD. Some years we do; other years we do not.

The CHAIRMAN. Do you mean during the irrigating season?

Mr. ALFORD. I do not think we use a tenth part, taking it in the whole irrigating season.

Senator JONES. What proportion of the entire volume of the river runs during the irrigating season?

Mr. ALFORD. That season is about from the 15th of May until the 10th or 15th of August.

Senator JONES. Three months. How much water does this river afford in the other nine months, compared with these three months?

Mr. ALFORD. Very little. I can not tell exactly. At this season the river is very low and will keep so until next May.

Senator JONES. And there is no water taken out of it?

Mr. ALFORD. Only for domestic use.

STATEMENT OF F. J. AMIES, OF FORT COLLINS.

The CHAIRMAN. You have heard the statements of Mr. Alford. Do you agree with him as to the duty of water in this vicinity?

Mr. AMIES. Yes.

The CHAIRMAN. He said he had had no experience in regard to the duty of water in raising vegetables. Have you made any observations in that respect?

Mr. AMIES. None myself. I only know those that have been taken at the college here—at the experiment station.

The CHAIRMAN. What would be the duty of water in raising vegetables?

Mr. AMIES. The duty of water would be at least 1 foot.

The CHAIRMAN. And you could irrigate so as to raise the different kinds of vegetables during the whole season with a foot of water?

Mr. AMIES. Yes; it is more distributed with vegetables than with grain crops. Grain crops require generally two irrigations.

Senator JONES. How about alfalfa?

Mr. AMIES. That requires one irrigation in the spring and sometimes two.

The CHAIRMAN. How much water does it take?

Mr. AMIES. I do not know.

The CHAIRMAN. Is it the practice here to flood alfalfa fields after cutting?

Mr. AMIES. It is customary.

The CHAIRMAN. What would be the amount of water necessary to irrigate alfalfa with that practice?

Mr. AMIES. It would take about two thirds of what it would take for ordinary crops.

The CHAIRMAN. It would take less than for ordinary crops?

Mr. AMIES. Yes. At each irrigation it would take two-thirds of what it would take with an ordinary crop of grain.

Mr. CHAIRMAN. How much for the season?

Mr. AMIES. About twice as much.

The CHAIRMAN. Is that a reason why you have to use more water with vegetables—that you have to irrigate more frequently?

Mr. AMIES. Yes.

STATEMENT OF A. L. EMIGH, OF FORT COLLINS.

The CHAIRMAN. You are deputy water commissioner of this district?

Mr. EMIGH. Yes.

The CHAIRMAN. Have you taken pains to ascertain as nearly as possible the amount of surplus water that runs away here in the average year?

Mr. EMIGH. I have taken a number of years, so as to get an average. I know pretty well what ran to waste this year, and it was under the average.

The CHAIRMAN. This has been a very dry year?

Mr. EMIGH. Yes.

The CHAIRMAN. What proportion of the whole ran away this year?

Mr. EMIGH. For about ten days there was a surplus. There were 2,000 cubic feet per second for several days. For the balance of the time, say a week, there were as much as 400 or 500 feet that ran to waste.

The CHAIRMAN. What proportion of the whole amount ran to waste probably during the season?

Mr. EMIGH. I can not say; I have not figured that up.

The CHAIRMAN. It would cover considerably more land?

Mr. EMIGH. Yes. There was enough ran to waste this year to irrigate (if you saved every inch of it) every square foot of arable land in the valley.

The CHAIRMAN. More than you have under cultivation?

Mr. EMIGH. Yes.

The CHAIRMAN. Have the crops suffered by reason of not having the water properly distributed?

Mr. ALFORD. The potatoes and corn have. The early crops have not.

Senator JONES. What is the discharge of this river by the month?

Mr. EMIGH. We have a record of it, but it varies very much. We have nearly 4,000 cubic feet per second as the highest, this year, in one day.

The CHAIRMAN. What I want to get at is the flow of the river outside of the irrigation season; what is the usual or normal flow in September say; has it been gauged?

Mr. EMIGH. Yes. I have not the record, however. About 225 feet is the usual flow per second in August when it gets down.

The CHAIRMAN. That would be about the usual flow outside of the irrigating season?

Mr. EMIGH. Yes.

The CHAIRMAN. For eight months?

Mr. EMIGH. Yes.

The CHAIRMAN. That would make a total of about 2,000 feet a second, for one month's time?

Mr. EMIGH. Yes. To fill all the ditches, if they are all running full, would take about 2,000 cubic feet per second. The decrees of the court are for a good deal more, but it actually takes that.

Adjourned.

GREELEY, COLO., *September* 17, 1889.

The committee met pursuant to call of the chairman.

Present, Mr. Stewart (chairman), and Mr. Jones, of Arkansas; also Director Powell.

STATEMENT OF JOHN L. ROUTT, OF DENVER.

The CHAIRMAN. How long have you resided in Colorado?

Mr. ROUTT. Fourteen and a half years.

The CHAIRMAN. You have been governor of the Territory and of the State?

Mr. ROUTT. I was the last territorial governor and the first State governor.

The CHAIRMAN. What is your occupation now?

Mr. ROUTT. I am cattle raising and farming. I have mined some.

The CHAIRMAN. Have you paid attention to the production of crops by irrigation? If so, state the character of the crops and the quantity produced of the various cereals and vegetables.

Mr. ROUTT. I have been engaged in farming for the last five years. I have two ditches on my land; have experimented somewhat with farming products and have succeeded pretty well in some things. I have raised three full crops of alfalfa every year but this. The third crop this year was a little short for want of water. My ground will yield about 5½ tons to the acre this year, counting the three cuttings. I have raised corn, from 25 to 50 bushels to the acre, without irrigation.

The CHAIRMAN. Was that in the low lands, where there was seepage?

Mr. ROUTT. It was in made land, the wash from the foot-hills. It was a level piece of ground with a good deal of sand and lime in it. The erosion of the rocks made a sediment so that I am able to plow pretty deep, and I raise corn in that way. I have to irrigate the oats and the alfalfa.

The CHAIRMAN. What is the average and what is the best crop of oats?

Mr. ROUTT. The best I have been able to raise is 25 bushels to the acre; the oats weighed 43 pounds to the measured bushel.

The CHAIRMAN. What is the average crop for the State?

Mr. ROUTT. About 40 bushels by weight.

The CHAIRMAN. How about wheat?

Mr. ROUTT. I am not familiar with the wheat, but I should think the crop of the State would average 25 to 28 bushels to the acre or somewhere along there, although some extra crops yield over 50 bushels.

The CHAIRMAN. Do you raise vegetables of all kinds here?

Mr. ROUTT. All kinds except the tropical vegetables. We can not raise tropical vegetables here, but this is a great potato country. It is also a great country for cabbages, beets, and all the ordinary varieties of vegetables.

The CHAIRMAN. Have there been experiments made in regard to fruits in different parts of the State?

Mr. ROUTT. Yes.

The CHAIRMAN. What do you say of the capacity of this country to grow fruit?

Mr. ROUTT. We are growing very good fruit in Colorado. We raise excellent apples. This part of the country is not well adapted for peaches, but almost all other sorts of ordinary fruits grow well here.

The CHAIRMAN. Have you made any experiments to ascertain the duty of water?

Mr. ROUTT. Yes; but that is pretty hard to explain.

The CHAIRMAN. I mean the amount of water necessary to water crops?

Mr. ROUTT. That depends upon the quality of the land. It will take double the quantity of water on some kinds of land that it will on others. A sandy loam that is not so sandy but what it will raise a good wild grass will take less water than a clay land. I think it will produce good crops with one-third less water than clay land. On the clay land it takes a long time to flow before you get all the land wet.

The CHAIRMAN. How much does it take any kind of land to get wet?

Mr. ROUTT. They estimate that 1.45 cubic feet flowing past a given point per second every day will irrigate 80 acres of land. I do not use anything near that much water, however, on my land.

The CHAIRMAN. Has the irrigation made the land too wet in any place?

Mr. ROUTT. You can kill land by too much water just as well as you can kill it by want of water.

The CHAIRMAN. Are there any places in this section of the country that have been injured by too much water?

Mr. ROUTT. Yes; you passed through much land of that kind near Fort Collins. They have to ditch the land out now so as to drain it and take off the surplus water.

The CHAIRMAN. Can it be drained so as to restore it to its original good quality?

Mr. ROUTT. That I can not tell.

The CHAIRMAN. At the experiment station did you observe where they had drained the land?

Mr. ROUTT. Yes, I noticed that; but they have not had a full opportunity to determine the fact of full restoration. I see no reason, however, why the land should not be restored, though I can not speak from actual experience.

STATEMENT OF J. MAX CLARK, OF GREELEY.

The CHAIRMAN. What is your occupation?

Mr. CLARK. I am a farmer.

The CHAIRMAN. Have you been farming in this vicinity by irrigation?

Mr. CLARK. Yes.

The CHAIRMAN. Have you given considerable attention to the subject of irrigation and the use of water?

Mr. CLARK. I have.

The CHAIRMAN. Can you state what results have been secured here as to the duty of water?

Mr. CLARK. We average, I suppose, something like a cubic foot per second for 60 acres for the season. It varies a little, but I think that is about the average. It varies with the different soils.

The CHAIRMAN. You reckon that, that cubic foot will do for how many days?

Mr. CLARK. For the season through.

The CHAIRMAN. What do you call the season?

Mr. CLARK. About one hundred days.

The CHAIRMAN. Do you require that for all kinds of crops?

Mr. CLARK. There are some kinds of crops that would require more and some that would not need so much. The average of our farmers grow some alfalfa, wheat, and potatoes. For such crops as we grow we want water all the time for about one hundred days.

The CHAIRMAN. Do you irrigate every day?

Mr. CLARK. Pretty nearly every day.

The CHAIRMAN. Not the same land?

Mr. CLARK. No.

The CHAIRMAN. You change around?

Mr. CLARK. Yes.

The CHAIRMAN. How often do you irrigate the same land during a season?

Mr. CLARK. As to alfalfa, I would rather water it three or four times a season. We can not do that, however; we have not enough water. But we would rather water it after cutting it in the spring and after the last cutting in the fall. When I say we use the water continuously, I

do not mean that we are applying the water every day to the same spot.

The CHAIRMAN. Have you any means of economizining the water by running it in pipes or putting some coping on your ditch?

Mr. CLARK. Not here.

The CHAIRMAN. How do you flood the land?

Mr. CLARK. We flood the entire surface. For potatoes and corn we run the water down between the rows. We water every row when we can; when we can not we do less and get a less crop.

The CHAIRMAN. Has any of your land been injured by having seepage water settle upon it?

Mr. CLARK. I do not think the land has been injured.

The CHAIRMAN. Injured for immediate use, I mean.

Mr. CLARK. Yes; we have considerable bodies of land in low places where the soil is of such quality that it will get wet and will not dry itself.

The CHAIRMAN. Do you reclaim that?

Mr. CLARK. Yes.

The CHAIRMAN. How?

Mr. CLARK. We drain it by ditches.

The CHAIRMAN. Does that restore it?

Mr. CLARK. Yes.

The CHAIRMAN. Is there a deficiency of water here sometimes?

Mr. CLARK. Yes.

The CHAIRMAN. Does some water go to waste in the flood time?

Mr. CLARK. Yes.

The CHAIRMAN. What means, if any, do you take to save the flood water to use for irrigation?

Mr. CLARK. We have a few natural depressions in the foot-hills and in the mountains where we store some of this water in the high stage, and use it afterwards, but those places which we can make use of with the expense which we can afford are not numerous.

The CHAIRMAN. Where you store the water in such places is the seepage great, or do the places hold the water pretty well?

Mr. CLARK. The seepage is great, but the water gets back into the main stream again and there is very little loss, only by evaporation, which, of course, we might not perceive, because it may be carried off into Nebraska or Kansas, but all seepage generally returns to the river. I believe it is estimated that there is not over 15 per cent. of the water that actually dries up in the atmosphere.

The CHAIRMAN. Are there opportunities for saving the flood water?

Mr. CLARK. Yes, there is no trouble about that, but all we want is money. It is too expensive for private enterprise. It is more expensive than we have been able to accomplish.

Senator JONES. How expensive would it be?

Mr. CLARK. I will make a statement to show you what I think about it. We have up on the river here a natural depression called Boyd's Lake. We wanted very much to make use of that as a reservoir to help us out. We had no doubt but that we would receive great benefit if we could use it, but we find on making careful estimates that the attempt to make proper ditches to that reservoir would cost more money than the entire capital stock invested in the two ditches that we were proposing to invest in. We have been here nineteen years and this one reservoir would cost more money than we ever put into our ditches.

The CHAIRMAN. How much is that?

Mr. CLARK. One hundred and fifty thousand dollars.

Senator JONES. It would cost that much?

Mr. CLARK. It would cost just that to do what we were trying to do. There ought to be two good ditches—one from the Thompson and one from the Poudre, so that we could take from one or the other as the water might be found most in either.

The CHAIRMAN. How much water would that reservoir hold that you wanted to make?

Mr. CLARK. I believe it was calculated to be three-quarters of a mile wide and 3 miles long, and would hold about 30 feet of water.

The CHAIRMAN. How much land would that irrigate?

Mr. CLARK. There were different opinions about that, but there is no doubt that it would be a very great benefit to this whole valley. We have completely exhausted the stream, except in the high-flood time, early in the spring. There is not a year that we have enough water for the proper growth of crops to get the yield that we ought to get, and that we know we can have when we have proper water.

The CHAIRMAN. Does it make any difference in the quantity of water required, whether the amount is properly distributed or not?

Mr. CLARK. Yes.

The CHAIRMAN. What effect has cultivation on the amount of water required to produce crops?

Mr. CLARK. Just the difference in quantity required, I can not say; but we all know that with potatoes and hoed crops, if we stir the ground up immediately after watering, it is improved.

The CHAIRMAN. How is it with wheat? Did you try summer fallowing here?

Mr. CLARK. Yes.

The CHAIRMAN. How does that result?

Mr. CLARK. The wheat will burn a great deal quicker the next year, but if it was watered and plowed two or three times the year before, you will get a large crop. If you put a piece of ground in wheat that you had in corn the year before and were not able to water it thoroughly, you can trace every spot just where the water was before.

The CHAIRMAN. Have you tried summer-fallowing the ground and not irrigating it to see what the result would be?

Mr. CLARK. I have, yes. I do not say that is not beneficial to summer-fallow, but if you let it go a whole season without water, you can not get a good crop here next year.

Senator JONES. What is an average crop of potatoes here to the acre?

Mr. CLARK. I suppose about 100 bushels to the acre on an average. That is not anything like the crop we could obtain, however.

The CHAIRMAN. What is a maximum crop?

Mr. CLARK. About 400 to 600 bushels.

The CHAIRMAN. You cannot raise potatoes without irrigation?

Mr. CLARK. Not successfully.

The CHAIRMAN. How much wheat do you get to the acre on an average?

Mr. CLARK. I have averaged as much as 25 bushels per acre for nineteen years. I do not remember to have ever raised less than 20 bushels to the acre in a single season.

The CHAIRMAN. What is the largest crop you ever got, taking the entire crop?

Mr. CLARK. I have averaged 37½ bushels. I have raised 30 bushels, 35 bushels, 32 bushels, and 33 bushels, according to the year.

The CHAIRMAN. Do you raise corn to any great extent?

Mr. CLARK. No.

The CHAIRMAN. Your principal market crops are wheat and potatoes?

Mr. CLARK. Yes, and alfalfa.

The CHAIRMAN. How much alfalfa do you get to the acre?

Mr. CLARK. From 4 to 5 tons. I have raised 5 tons repeatedly. I suppose 4 tons would be an average crop.

STATEMENT OF BENJAMIN H. EATON, OF GREELEY.

The CHAIRMAN. You have been governor of this State?

Mr. EATON. Yes.

The CHAIRMAN. We would like to have you give us something of the history of the colony of Greeley and your experience with it.

Mr. EATON. In 1869 I saw an article in the New York Tribune, inviting people to meet Mr. M. C. Meeker, to form a colony to come to the frontier country, cut loose from the evils of eastern civilization and locate on the arid plains or in a new country and start a pure and holy colony, so to speak. I was rafting on the river, the Caché la Poudre, and I immediately wrote to Mr. Meeker that here was the place. I saw him at Evans four months afterwards and he said, "You have helped to get us here and we want you to join us and our colony." I did so. So I am one of the original colonists.

The colony was located here on a barren plain or cactus bed in a very dry spring of 1870. There was not then a house or a building or anything of that kind here. The first season was a very unpromising one. At that time no one in this section of country thought that there was any good land here except the land along the river, watered by capillary attraction. People had great hesitancy about farming here because they had no faith in the soil. In fact, as just stated, it was a new thing. There was no upland farmed.

This Greeley colony was the first pioneer to take a hold of the uplands or cactus-bed.. Hundreds and perhaps thousands of people came here, but very few remained. They came from all over the United States, especially from the town portion, of different trades and different professions. There was not very much to be seen in the prospects of the soil.

I, myself, had not faith enough in it to take a claim, but as I lived up the river, I took interest in it and watched it. The second year there was a little plant food put in the soil. It was all absorbed and they were able to raise nothing ,but they did better the third year. If a friend came to the house and asked me how much faith I had in these uplands, I would turn the question a little and would not like to tell him. Next year, the land was all taken up. Enough people remained that had faith in it, and altogether it made a colony. At that time there was but very little water in the river late in the season. This Greeley canal irrigated, I think, some 4,500 acres the first year.

Senator JONES. Did they begin irrigation at once when they came here?

Mr. EATON. Yes.

Senator JONES. You have not made any statement about that yet. State what was done.

Mr. EATON. They laid off a ditch and commenced to construct it, and as fast as it was constructed they turned the water in.

Senator JONES. These were irrigated lands that you said made poor crops the first year and did better the next year?

Mr. EATON. Yes. When I speak of high lands, I mean lands that showed no signs of vegitation except the cactus or something of that kind. At that time there was about 4,500 acres irrigated, I believe, under this colony ditch, what we now call the "Caché la Poudre canal, number two." They made that 4 feet deep and 2 feet wide, I think, at the head. It ran out to the railroad, some 24 miles. There it was a little ditch, but next year they enlarged it, and now it is 25 feet wide and 6 feet deep, owing to the natural wear of the ditch and the crooked places having been made straight. It flows now, perhaps, ten or fifteen times the water it did the first year. That ditch has been extended every year. That land has become wet by soakage. The land is now being drained.

The extent to which we can irrigate here is not determined, and will not be in our time. The water is flowing out all the time. By the reservoirs in the mountains, we are able to save a large amount of this water that in former times ran down stream. Some ditches take it all, and others are imperfect and do not take it all, but it does not go very far before it gets back into the river again. There are many depressions in the valley, like Boyd's Lake, that was mentioned, that could be made into good reservoirs. But that is expensive, and the people are not rich. Many of them would not have staid here if they could have got away. It was a matter of necessity for them to stay, though they do not talk that way now. They are now willing to stay. Much more water could be got if we had help. The snow-fall has not been so heavy as usual this last year. There were fourteen or fifteen days last year in which, if we had the water stored that went to waste, we would have saved several hundred thousand dollars.

The CHAIRMAN. In a single year.?

Mr. EATON. In that single year. But at other times the stream would flow the amount of water that it has flowed this year.

The CHAIRMAN. And ten times the amount of water that was used?

Mr. EATON. Yes. This river has been flowing so full sometimes that you could not tell where the channel was because of the overflow. It has 16 feet of a fall from here to Fort Collins, and 25 from there to the mountains. Water that falls like that does not pay much attention to a channel.

The CHAIRMAN. Has the country been surveyed to see what could be done?

Mr. EATON. No, I think not; only by slight individual enterprise.

The CHAIRMAN. Would a survey be of benefit to you?

Mr. EATON. It does not require much to know that an immense amount of good can be done if we have reservoirs or ditches. Every man can see the depressions.

The CHAIRMAN. How many people are there, do you suppose, in the east, that believe anything in it at all?

Mr. EATON. Seeing is believing; all believe it who see it.

The CHAIRMAN. The committee desires to ascertain facts and report to Congress. We have not expressed any opinion as to what will be done, and it is improper for us to do so. There will not be much done until all the people understand it as the people of the West do. We are trying to get at the facts, as to what kind of country you have, and as to what can be produced, and what people can do if they come here. To what extent then could the farming land be increased if water were properly used from this river?

Mr. EATON. You would have to limit the time in order that I might answer that question properly. It will depend on the winters and the

depth of snow. Large ditches could be constructed to use when water is high; and they would make water available for the other seasons. It is impossible to say how much exactly could be done. Everything depends on moisture. There are large ditches on the flat that are caused by seepage and overflow.

The CHAIRMAN. Can you say generally that it is possible to largely increase the irrigation by reservoir?

Mr. EATON. Yes, that could be undoubtedly done.

The CHAIRMAN. Then, the opportunities for making new homes, even in this vicinity, where you had early irrigation, are not exhausted at all?

Mr. EATON. By no means. New homes are being made all the time, and ditches are being constructed, but for the last two years ditches have been constructed and preparations made to receive the water more rapidly than the water has been available.

The CHAIRMAN. More rapidly than water has been increased by storage or other development.

Mr. EATON. Yes. There is an excellent opportunity for making a reservoir on Chamber's Lake, up in the mountains, and many others are available. You can not tell how much can be done, because past seasons are not fair samples.

The CHAIRMAN. What do you say of this as a good country to live in, with irrigation?

Mr. EATON. It is the best country I know of.

The CHAIRMAN. Why is it best?

Mr. EATON. We have a great deal of sunshine. Many people do not think that that is much of an advantage, but it is an advantage in harvesting crops. We harvested our crops this year without losing a pound, I might say, by "must." In many years, east of here, the crops are destroyed in the harvest season.

The CHAIRMAN. How is it as to the certainty of crops if you have irrigation?

Mr. EATON. With irrigation crops are certain.

The CHAIRMAN. Do you repeat the same crops on the same land?

Mr. EATON. We have done so, but it has not been good. We are rotating now.

The CHAIRMAN. Does land grow better or poorer each year?

Mr. EATON. It grows a little poorer. The lands have been farmed here for twenty years and we raised very good crops last year. I have heard people say that they had 40 bushels of wheat to the acre, but it was on new land.

The CHAIRMAN. As to alfalfa, does the crop increase or decrease year by year?

Mr. EATON. There is one place that has been cut forty-four times, that is, three times a year for fifteen years. This year it is as good as in any former year.

The CHAIRMAN. You say that alfalfa is a great fertilizer?

Mr. EATON. Yes.

The CHAIRMAN. What crops do best immediately after alfalfa?

Mr. EATON. Wheat and potatoes. Some people put in potatoes and some put in wheat. Alfalfa roots are very hard to plow up, but some find it best to plow them up and put in wheat. That saves them from contending with the roots, with the stubs that have not been thoroughly cut off.

Senator JONES. Is there any trouble in destroying alfalfa?

Mr. EATON. It is very hard to plow.

Senator JONES. But after the first plowing is there any trouble?
Mr. EATON. No; it decays at once.
The CHAIRMAN. Did you ever try destroying it by flooding it?
Mr. EATON. No; I have heard of people flooding it late in the fall, at a time when we do not have much water. Hard freezing will kill it, but I have never tried it. We are not trying very hard to kill alfalfa.
The CHAIRMAN. What use do you make of it?
Mr. EATON. It is a good forage plant and is fed to cattle and sheep for fattening purposes.
The CHAIRMAN. Do you feed it to hogs?
Mr. EATON. I have heard of hogs getting fat lying around about it, but I have never seen them do it. It is a good feed for hogs, but does not make them very fat. I ought to say, perhaps, that irrigation is a wonderful success in this country and community.
The CHAIRMAN. You have a fine country out here?
Mr. EATON. Yes; the people are doing pretty well and are putting more paint on their houses.
The CHAIRMAN. They are getting into a little better financial condition each year?
Mr. EATON. Yes, I think so.

STATEMENT OF DAVID BOYD, OF GREELEY.

The CHAIRMAN. What is your occupation?
Mr. BOYD. I am a farmer.
The CHAIRMAN. Where do you reside?
Mr. BOYD. In Greeley, sometimes, and sometimes on my farm between here and Eaton. My family live in Greeley and I live there sometimes.
The CHAIRMAN. You are farming here by means of irrigation?
Mr. BOYD. Yes.
The CHAIRMAN. You have given some attention to the subject?
Mr. BOYD. Yes; I have been here since 1870 and had control of this canal when it was first built.
The CHAIRMAN. You are one of the original Greeley party?
Mr. BOYD. Yes.
The CHAIRMAN. Give us some of your experience as one member of that colony.
Mr. BOYD. I would say, as one differing in view from Governor Eaton, that I did not quite burn my ships when I came here. Neither did I put all my cargo in one ship. I am Scotch-Irish, and proceed cautiously. I did not put all my money in here. I was trying an experiment. I have been informing myself recently in regard to the statistics of irrigation in this irrigation division, and also in the Poudre. I would say that when we came here first, which was in 1870, a corporation was formed according to the laws of Colorado on the 15th of April of that year. The officers of the colony issued a circular stating that they proposed building four canals, which were to cost, according to estimate, $20,000 for the four. This was information for the colonists at large. Only the second and third canals were ever taken out by the colony. No. 3 was built first, in the spring of 1870, and it cost, on first construction, $6,000. We found that it was utterly insignificant and utterly useless for our purposes. We put in 200 acres. I know exactly what was put in because I managed, or rather mismanaged, the canal for the first year. An enlargement had to be made. All the land was put in town

lots and everything. It was a scarce year for water. The ditch was poorly constructed. In points it would carry much water, and in points it would not carry any. It was made zigzag. The engineer who did it was one who had run ditches in mountains, and of course he must follow every acute angle. We enlarged that the next year at a cost of $5,000 more. This ditch has cost us $25,000 and irrigates about 4,000 acres of land.

In regard to ditch No. 2, which is across the river; that cost on first construction $27,000. Two thousand acres were put under that canal. A large part of that went under for want of water, because the canal was poorly constructed. My friend Max Clark put in 80 acres and lost it all. Then we had to make another enlargement. We made altogether three enlargements, costing us $60,000. This was done by the colony. It was turned over to the farmers in 1887. They have spent since that time $25,000, making the total cost of canal No. 2 $112,000. I am sure of the figures because I have been over the colony books. They never constructed ditch No. 1. A portion of the land which was to be covered by it had a ditch built by the Larimer & Weld Company.

Senator JONES. How much land is irrigated by canal No. 2?

Mr. BOYD. About 25,000 acres. There are one hundred and twenty 80-acre water-rights (or the equivalent thereto) in it. The actual cost is $350 per 80-acre water-right, while in the Larimer & Weld, above it, each water-right costs $1,200. We found that a cubic foot of water per second would irrigate about 65 acres.

Canal No. 4, which used to come out at Big Thompson, and covered the land south and west of town, was not constructed by the colony, but by Captain MacKenzie, and is now owned by an English company. It cost $50,000. So that those four canals, which the colonists expected to build for $20,000, actually cost $400,000.

Senator JONES. How much land is irrigated by canal No. 4, which, you say, cost $50,000?

Mr. BOYD. I have not looked over the statistics. I can not give the figures.

Senator JONES. What was the total cost of canal No. 1?

Mr. BOYD. The total cost of that, or of the two canals covering the same land, would be about $200,000.

Senator JONES. How much land is irrigated by that?

Mr. BOYD. Twenty-seven thousand acres are now irrigated by the Larimer & Weld, which is part of the land that would be covered by No. 1. It covers, say, one-half, and we may safely assume that the Larimer County ditch, still above, and covering land that would have been covered by No. 1, will irrigate the same area.

Senator JONES. Twenty-seven thousand more?

Mr. BOYD. Yes.

Senator JONES. That makes 54,000 acres, then, that you say are covered by a ditch that cost $50,000.

Mr. BOYD. Yes.

Senator JONES. This is what is embraced in what was the original colony ditch No. 1?

Mr. BOYD. Yes.

The CHAIRMAN. Have you enumerated all the ditches?

Mr. BOYD. These are the four ditches that were proposed.

The CHAIRMAN. Are there others?

Mr. BOYD. There are some 50 ditches from the Caché la Poudre.

The CHAIRMAN. Do you know the expense of constructing all those?

Mr. BOYD. No; I can say, however, that the two canals, the Union

colony, and the Larimer & Weld, covers about as much land as all the rest; they being all small ditches.

The CHAIRMAN. How much do they irrigate?

Mr. BOYD. Fifty-two thousand acres (that is, 27,000 and 25,000). Of course these figures are approximate. The whole area, as estimated by the commissioner, of all the canals taken out of the Poudre (which is district No. 3) is 108,000 acres.

The CHAIRMAN. Has there been any estimate of the entire cost of these?

Mr. BOYD. No; I have made no estimate. I could only do it approximately.

The CHAIRMAN. How much did the irrigation cost for the 52,000 acres that you irrigate; did it cost $400,000?

Mr. BOYD. No; these 52,000 are included in our No. 2, and the Larimer & Weld. The cost of those would be $100,000 for the Larimer & Weld, and $112,000 for our No. 2.

The CHAIRMAN, That is $212,000 for the 52,000 acres?

Mr. BOYD. Yes.

The CHAIRMAN. That would be a little over $4 an acre?

Mr. BOYD. Yes.

The CHAIRMAN. Is $4 an acre about the cost of irrigation here?

Mr. BOYD. That depends on whether you build, yourself, or whether you buy the water.

The CHAIRMAN. I mean the actual cost of the construction of the ditches.

Mr. BOYD. It varies very much.

The CHAIRMAN. I know that, but I mean the average?

Mr. BOYD. Take No. 3, which supplies the town; that is to say, 4,000 acres. That cost $25,000.

Senator JONES. That is a little over $6 an acre.

Senator TELLER. You must remember that those ditches were exceptionally cheap ditches, this valley being an easy valley to irrigate.

The CHAIRMAN. I want to know the cost of construction of ditches in this valley.

Mr. BOYD. No. 3 cost $25,000 and irrigates 4,000 acres. No. 2 cost $112,000 and irrigates 25,000 acres. The Larimer & Weld cost $100,000 and irrigates 27,000 acres. No. 4 cost $50,000, and I do not know how much that irrigates.

The CHAIRMAN. That is pretty cheap irrigating.

Senator TELLER. I would not like the committee to have an idea that that is the average cost of irrigating here. This is a peculiarly happy valley in regard to the cost of irrigation.

The CHAIRMAN. What do you say, Mr. Boyd, as to the feasibility of increasing the acreage of irrigated land here?

Mr. BOYD. In my opinion, what we need irrigation for is to finish crops that are under the ditch. For instance, we lose our potato crop nearly every year because of the shortage of water at the proper time. In regard to the amount of water that comes over this weir, I think the greatest amount of water that ever came over the weir at the cañon was 7,000 cubic feet per second. In 1888 the greatest quantity that came over it was 1,700 feet per second. That seemed to be sufficient for the amount of land, the 108,000 acres irrigated, and if you divide the 108,000 by 1,700 you will get somewhere about 60 acres as the "duty" of water, as it is called. If that had continued for any length of time we would have been all right, and would have saved our crops, but it soon fell. There was only one week when the ditches were dry.

The CHAIRMAN. You think if the water were stored and economically used you could prevent all failure of crops?

Mr. BOYD. Yes. We are especially devoted to the cultivation of potatoes. Last year we lost a large part of the crop because we had no late water. Late water is important because we can not raise an early crop of potatoes here. If we supply water early to them it makes them "set" and goes to producing tubers at a time when the soil is hot and dry. So we must have late water for potatoes. In 1877 we shipped 2,000 car loads of potatoes from Greeley. We had late water that year. Last year we shipped less than 1,500 car loads, because of the shortage of water. This year we will ship less.

The CHAIRMAN. How much would it enhance the average value of the irrigated land (supposing there are 108,000 acres of such land in the whole valley) to have a sufficient supply of water each year to mature the crops.

Mr. BOYD. I can best answer that by telling you what people are doing in order to get this late supply. There is a party here who has put in a pump to pump water for irrigating purposes. It costs him $14 a day to run that pump and he pumps a water right and a half. The question arises, does it pay him? It is said that he will have 100 sacks to the acre on 120 acres. That will be 12,000 sacks of potatoes, where he probably would not otherwise have had 12 sacks to the acre. So it pays him to have a pump at a cost of $14 a day, besides $3 a day for coal, and a man night and day to run it.

Senator TELLER. How much does it cost him a day for the water which he gets through pumping?

Mr. BOYD. He irrigates about 10 acres from his pump. If that be considered in comparison with what our water costs us, it would be cheap.

Senator JONES. Did I understand you awhile ago to say that if reservoirs were provided, so as to save the water from going to waste in this river, there would be only about water enough to make a certainty of the crops now under cultivation?

Mr. BOYD. That would depend greatly on the year and on the size of the reservoir.

Senator JONES. Take the average year and suppose there were reservoirs enough to hold the excess of water.

Mr. BOYD. There have been two years when there was very little to spare.

Senator JONES. They are exceptional perhaps.

Mr. BOYD. Yes.

Senator JONES. I was speaking of the average year and the ordinary flow of water.

Mr. BOYD. Take this year, which may be considered an average year, there might be a surplus of 1,000 feet per second.

Senator JONES. Did I understand you to say that that would be about the utmost that could be expected from storage of water on river?

Mr. BOYD. Yes; I really think it would be very unsafe for parties to build reservoirs.

Senator JONES. This seems to be very vague and indefinite information; one man stated here that there was not more than one-tenth of the water used.

Senator TELLER. That was in some years.

Mr. BOYD. I think 7,000 feet per second is the maximum that went down since Mr. Nettleton put in his gauge, and by decree of the court we have appropriated 4,632 cubic feet per second.

Senator TELLER. But not every year.

Senator JONES. He meant that it was in the exceptional year that they used only one-tenth of the water.

Senator TELLER. He meant that some years there would be ten times as much water running in the streams as compared with other years.

Mr. BOYD. Governor Eaton, I suppose, was thinking of a year when there was not any such large area or ditch capacity as we have now.

The CHAIRMAN. Does the land require more irrigation after it has been irrigated a few years?

Mr. BOYD. It requires much less; depending, however, largely, on the character of the subsoil. If gravel is near, and the water is scarce, there seems to be no particular difference—one year is as good as another.

The CHAIRMAN. Could you not increase the water very much by seepage from lands that have received too much water?

Mr. BOYD. Yes, we have improved the situation by drainage. There are pipes being arranged for that now.

The CHAIRMAN. What are the names of those now using the pump?

Mr. BOYD. Hurdle & Wilson.

STATEMENT OF GEORGE H. WEST, OF GREELEY.

The CHAIRMAN. Are you the manager of the concern here which has a new invention—that of a pump for irrigation?

Mr. WEST. Yes.

The CHAIRMAN. What are the general characteristics of the pump?

Mr. WEST. It is what is called a steam vacuum pump. It lifts the water on a short lift up to say 24 feet.

The CHAIRMAN. Being governed by what?

Mr. WEST. By the weight of the atmosphere producing a vacum.

The CHAIRMAN. Will 24 feet operate in this altitude as much as that?

Mr. WEST. About as much as that.

The CHAIRMAN. By actual experiment here you can operate the suction about 24 feet?

Mr. WEST. About 22 to the discharge and 24 to the top of the cylinders.

The CHAIRMAN. What are the virtues of the pump in the way of cheapness, etc.

Mr. WEST. It is operated very economically. The ordinary pump lifts the water against the weight of the atmosphere, while this is operated by the weight of the atmosphere.

The CHAIRMAN. Have you put it in actual operation anywhere?

Mr. WEST. Yes, we have quite a number of them in use on ranches in northern Colorado.

The CHAIRMAN. How much does it cost to elevate to a height of, say, 22 feet a cubic foot per second? What is the expense of the pump and what does it cost to operate it?

Mr. WEST. The entire plant—pump, boiler, and steam pipes, complete—cost, set up on the ranch, is $700.

The CHAIRMAN. That is, to elevate a cubic foot per second to a height of 22 feet?

Mr. WEST. Yes. The expense of fuel would be 1 ton of slack coal in three days' continuous pumping of twelve hours a day.

The CHAIRMAN. And for one hundred days (which would be the irrigating season) it will therefore be 33 tons of coal?

Mr. WEST. Yes.

The CHAIRMAN. What is the price of coal here?

Mr. WEST. Slack coal costs here, laid down, about $1.50 a ton.

The CHAIRMAN. Would hard coal give better service?

Mr. WEST. Yes, but not with the same economy in results of water.

The CHAIRMAN. So that about $40 or $50 worth of coal would last a season. Then what would it cost for attendance?

Mr. WEST. The same man can attend to the boiler who attends to the irrigation. That depends however on the size of the plant and the kind of boiler used.

The CHAIRMAN. I want to get it down to the cubic foot per second for 60 acres?

Mr. WEST. I think it would be fair to count $1 a day perhaps for attendance.

The CHAIRMAN. That would be $100 for the irrigating season?

Mr. WEST. For one hundred days, yes.

The CHAIRMAN. Then about $150 would be the expense for the season?

Mr. WEST. Yes.

The CHAIRMAN. That would be about $3 an acre?

Mr. WEST. It is about $2 an acre as I have figured it out.

The CHAIRMAN. That is, if you have to elevate it only 22 feet. You could not operate it except to the extent of the weight of the atmosphere?

Mr. WEST. We have another pump on the same principle, which elevates the water above the pump, by steam pressure—a combined lift and force pump. We can lift the water above the pump in that case 170 feet.

The CHAIRMAN. What would be the expense of raising it 170 feet?

Mr. WEST. We have not made any practical tests this year on that.

The CHAIRMAN. Have the farmers resorted to this method of procuring water to any considerable extent in Colorado?

Mr. WEST. It was introduced late this season. I think there are about thirty-five plants in operation, enough to test the water supply and also the question of economy.

The CHAIRMAN. Can you collect the facts as to the actual operation of the different plants and forward them to the committee?

Mr. WEST. I will do so.

Senator TELLER. You might state where you get this water.

Mr. WEST. We have under Greeley 46 feet of gravel stratum filled with water. We have first 4 to 6 feet of surface drift or soil, and below that comes this gravel filled with water, which extends down 46 feet farther to bed rock. On the Platte River, east of here, we have 84 feet of that gravel stratum filled with water.

The CHAIRMAN. What depth is there to it?

Mr. WEST. About the same depth, but the top soil may be a little lighter.

The CHAIRMAN. Are you familiar with the country below here, in Nebraska, and do you know how deep the water is below the surface there?

Mr. WEST. That varies according to the distance back from the streams. We find that in many of these dry creeks or arroyos there is water at a slight depth and also in the flats. At Crow Creek, 40 to 45 miles northeast of here, where there is only a little water in places coming to the surface, they find large quantities of water there at from 4 to 15 feet below the surface over a large area.

The CHAIRMAN. Have you any information as to how it is in Nebraska, on the Platte?

Mr. WEST. It is the same all along the Republican Valley. As you get on the divide or high land the condition seems to be that you get usually into water, although it is not so in all cases.

Senator JONES. You say that a $700 pump discharges about a cubic foot a second?

Mr. WEST. Yes.

Senator JONES. What is the size of the discharge-pipe?

Mr. WEST. The pump I speak of discharges right at the box.

Senator JONES. Have you measured the discharge capacity of the pumps?

Mr. WEST. Yes.

Senator TELLER. You mean to say, I suppose, that these people using the pumps are getting this subterranean water?

Mr. WEST. This gravel is very coarse, in places as large as your fist. That lies together irregularly, and there are great spaces or cavities between the pieces. As we pump the tendency is to throw this stuff out and open up great channels, and then there is a rush in of water. On the Albert Howard well, which is 70 feet deep and gives 22 feet of water for irrigation, there are two pumps for the 200 acres, and the water is lowered about 11 feet in pumping twelve hours per day. That leaves 11 feet to draw on. The amount of water underneath in these gravel beds seems to be enormous. Where we have found 12 feet of water in that stratum we have not put in any pumps yet that have pumped it dry. At Platteville, about 20 miles south of here, they have 60 feet of that gravel stratum, and nearer to Denver they have 50 or 55 feet in different locations.

The CHAIRMAN. If you will in condensed form give the results of your operations, the cost, and the amount of land irrigated, and also any information you may have as to water that is underground, down about the Platte, the Arkansas, or any other stream, we would be glad to have that information.

Mr. WEST. There are one or two other facts I would like to state concisely. One is that we have sold a number of those pumps for places where the streams run very sluggishly (2 to 4 feet per mile) and where it is impossible to take out ditches. In other cases, for instance in Bear River, in Routt County, the condition there is that of a great difference (12 feet) between high water and low water in the streams. There the valleys are narrow and the people are not able to take out large ditches. For that reason their ditches are too small and are built for high water. When that water drops, their ditches are left dry, and their crops have to dry up for want of water. That is the condition of many localities, particularly in the parks and mountains. On Bear River they have coal that they can put right into a wagon without any cost of hauling.

The CHAIRMAN. In your statement give us an explanation of raising of the water up from a distance of 4 or 5 feet. It may be useful.

Mr. WEST. You mean the fuel expense for different elevations?

The CHAIRMAN. Yes.

Mr. WEST. Yes. It might be well for me to state also that we have had letters from Arizona, New Mexico, western Kansas, western Texas, Utah, Montana, and elsewhere, giving indications that there are localities where it is impossible to irrigate except by raising the water by

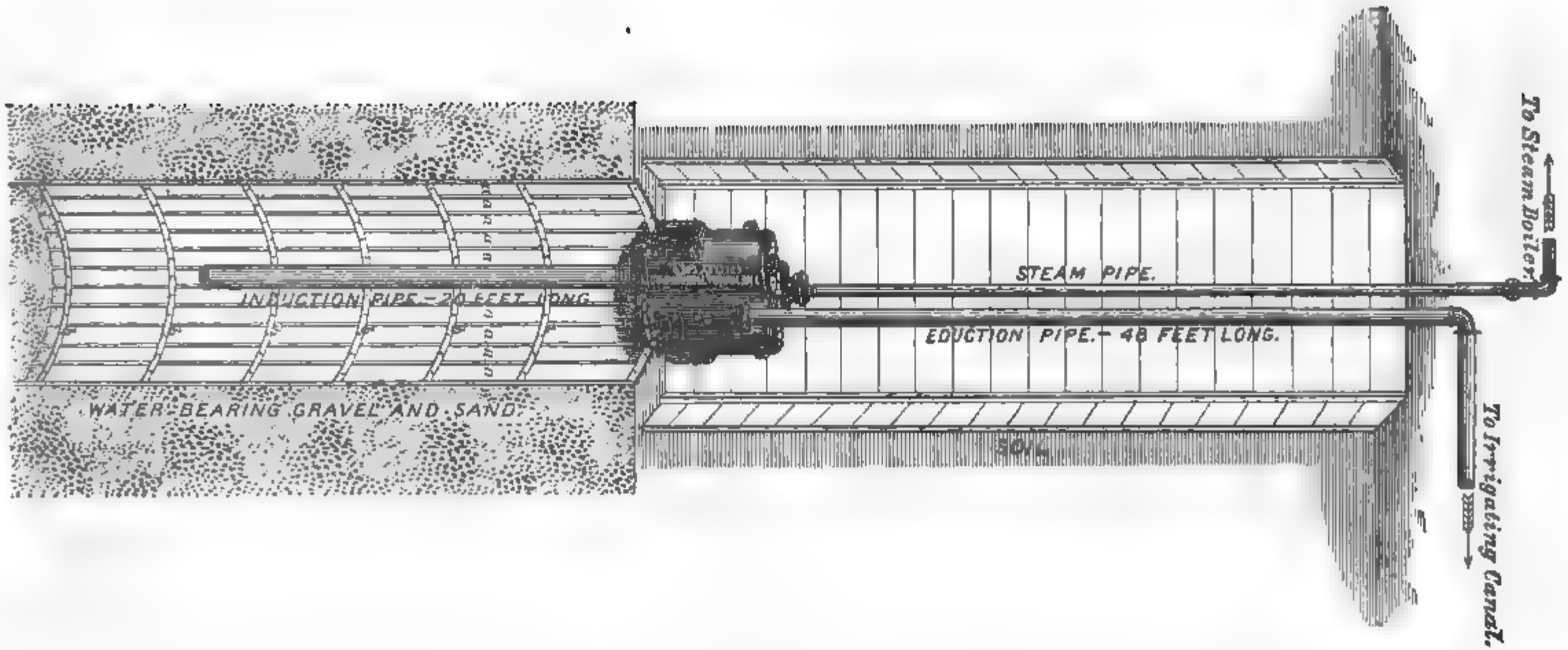
mechanical power, and where they have regular rivers of water under ground.

The CHAIRMAN. You can condense all of that information that will be of use. When received it will be placed in evidence.

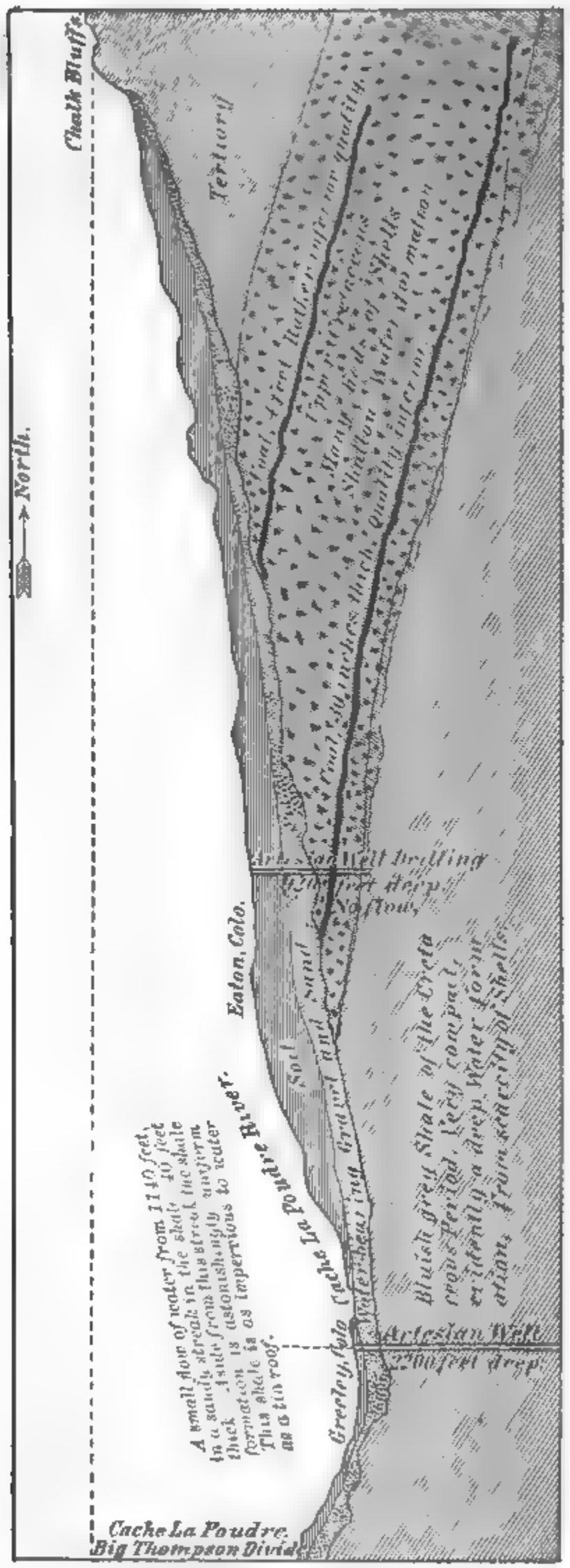
FURTHER STATEMENT OF GEORGE H. WEST.

In Greeley we have given much attention this season to elevating the underground water to the surface for irrigation. This idea had its inception in the lack of water to mature our crops under the old irrigating-canals in this section. In the year 1888 the loss on the potato crop tributary to this city was estimated at $250,000, this year at $300,000, from lack of water solely, the crop being perhaps three-fourths made and then burned up. This loss occurred with an abundant supply of water under every ranch in the valley at from 4 to 30 feet from the surface in coarse gravel. Much study has been given to this matter and the machinery used is cheap, simple, durable, and economical. The pumps commonly used in Colorado are of the class called steam vacuum pumps, operated with steam-boilers, requiring no engine, and lifting the water by vacuum or atmospheric pressure through automatic condensation of steam in the two pump cylinders alternately. They are of two kinds, one making the atmospheric lift only, say, 22 feet here, and the other the same lift of water into the pump, thence forcing it above 150 feet higher, by steam-pressure in the cylinder. Being without plungers or pistons, muddy water, sand, and gravel do not interfere with their operation. On a simple vacuum lift they can be operated with less than 1 pound steam-pressure and discharge their nominal capacity with 5 to 10 pounds steam-pressure and on a lift of only 4 to 12 feet with from 25 to 30 pounds steam-pressure the discharge is about doubled. Figuring on a pump of nominal capacity of 450 gallons a minutes, being 1 cubic feet per second, or 50 miners' inches, the theoretical discharge is as follows: One pound of coal in an average boiler should convert 1 gallon of water into steam. Water at the altitude of Greeley—4,778 feet—is converted into steam at about 202 degrees. Steam occupies here relatively 1,993 times the space of water. Allowing 493 parts steam for waste, and also that the water displaces the steam in the cylinders space for space, we should get 1,500 gallons of water for every pound of coal used and every gallon of water converted into steam. In actual practice we have done about one-half of this, discharging 1 cubic foot of water per second 20 feet high with 35 to 40 pounds of good soft coal per hour. The ranchmen in actual use, often use consume 50 per cent. more coal than this.

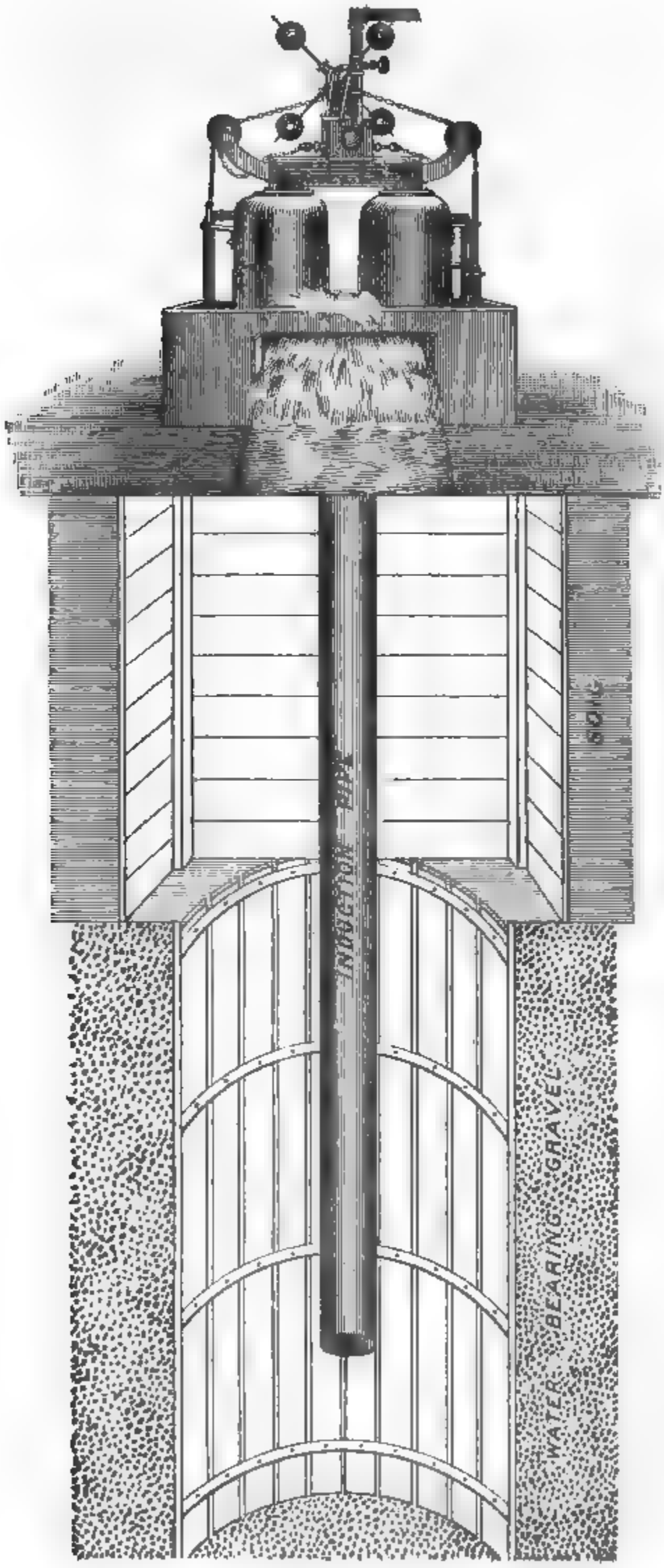
The accompanying sketch (No. 1) is a section (one-half) of a deep well (Albert Howard's) on the bluff north of this city. There are two pumps in this well, set on top of the curb just above the water level, both operated by one steam boiler. Mr. Howard has irrigated 200 acres of land with this plant at an expense of $2 per acre for fuel and labor for the season's irrigation. This well is 68 feet deep, 46 feet from the surface of ground to water, and with 22 feet depth of water. The discharge is 2 feet above the surface of the ground. These pumps, operated twelve hours per day continuously, lower the water 11 feet, and the average lift is 53½ feet. A 60-horse power horizontial steam boiler is used, consuming about 1¼ tons of inferior slack coal in twelve hours, costing $1.50 per ton. The water-bearing strata is coarse gravel. These pumps discharge about 1,400 gallons per minute, being about 3



Sketch No. 1—Represents Albert Howard's well and pump on the bluff 2 miles north of Greeley, Colo. Length of square curb is 48 feet; length of round curb 25 feet, of 2 inch plank by hoops of iron bolted through each plank. The 2 inch plank are bolted on the *outside* of the iron circles. There is one-half an inch of space between each piece of timber, through which the water finds its way freely into the well. There are two pumps in this well, only one being shown in this drawing. The water stands level with the top of the round curb in this well when the pumps are not running. Water-bearing gravel and sand indicated by the dotted work.



Sketch No. 2—This is of an actual well in sections. The horizontal line work indicates the dry soil, and the dotted-work the water bearing gravel.



Sketch No. 1—Shows a purely vacuum pump, from a photograph of the pump, when doing actual work. This pump makes a total lift of 23 feet.

cubic feet of water per second, or 150 miner's inches, under a 4-inch head of pressure. These pumps will deliver about one-half more water on a 22-foot lift. The entire cost of this pumping plant was less than $2,000. Mr. Howard's experiment was the pioneer one in the United States.

A simple steam vacuum pump on the Robert Boyd ranch near this city is shown by sketch No. 3. It has a normal capacity of 500 gallons discharge per minute on a 20-foot lift. This pump is elevating seepage water 14 feet high from the Cache-la-Poudre River through tiling laid in a trench dug horizontally into the bank some 20 feet. One 14-horse-power vertical steam boiler is used, and with 30 pounds pressure the pump discharges about 1,000 gallons of water per minute, being about 2¼ cubic feet per second, or 110 miner's inches. One ton of slack coal is used in three days' pumping of twelve hours per day. A boy runs the plant. More water could be furnished by this pump than was required for the area cultivated. The expense for fuel and labor was 50 cents per acre for each irrigation. The entire cost of the plant was $700, and the pump will irrigate 80 acres of land on a 20-foot lift. The cost of a similar complete plant for irrigating 160 acres would be $1,000, and for 320 acres $1,200. The price of these plants and the cost of fuel and care per acre decrease rapidly as the acreage increases. In a general way, complete pumping plants of this kind for large tracts of land would cost $3 to $5 per acre. When the land is in small tracts, the best results would be obtained by co-operation in the use of large plants. The form of wells constructed for use of these pumps is shown in sketch No. 2.

The valleys of Colorado on the eastern plateau have all been formed by denudation; the streams from the mountains have left on the bed rock deposits of sand and gravel filled with water, varying in thickness from a few inches to 64 feet at Eaton, Colo. This bed of water-bearing sand and gravel in the Cache-la-Poudre Valley extends from Greeley to the foot of Chalk Bluffs, 39 miles north and 1,220 feet higher. The sketch presented illustrated this. Near the foot-hills large bowlders lie next the bed-rock, and farther east on the plains their size decreases regularly to large stones, coarse gravel and sand, all filled with water. From the surface to bed rock the conditions are reversed, and below the soil we reach quicksand or sand, then fine gravel, coarse gravel, large stones, etc. Water is usually found on the plateau east of the mountains as soon as the gravel is reached, and back from the rivers for miles in the valleys water is usually found beneath the surface at the same level as in the surface streams. The water-bearing strata near the surface is comparatively narrow at the foot-hills, but widens out many miles as we reach the valleys, where the surface streams have less fall to the mile. Since the construction and use of irrigation ditches the amount of water in the gravel strata has greatly increased, often standing much higher than the level of water in the natural streams, and coming to the surface as seepage in lakes and ponds.

The distance from the surface to the subterreanean water varies from a few feet to more than 50 feet in the valleys of the Cache-la-Poudre, South Platte, and Big Thompson Rivers and their tributaries. At Greeley, in the river valley proper, water is found from 4 to 16 feet from the surface, and the water-bearing gravel is 44 feet thick; at Eaton, 8 miles north this water strata is 20 to 25 feet from the surface and is 64 feet in depth; at Pierce, 10 miles still farther north, this water strata is 30 feet from the surface, and continuing 20 miles again north,

to the Maynard Flats, near Carr station, water is but 8 feet from the surface, in gravel. The depth of the water-bearing strata in the latter locations have not been determined. Water is found also in gravel on Crow Creek and Little Crow flats, 40 to 50 miles northeast from Greeley, at varying depths from 4 to 20 feet, in large quantities. At Denver, bed rock comes to within a few feet of the surface, and good results have not been obtained; but large amounts of water are found in the sands of Cherry Creek and in the valleys adjacent thereto. North from Denver, along the South Platte Valley, water is found at varying depths from 8 to 30 feet, and the water-bearing gravel is 50 feet thick at Brighton, 55 feet at Fort Lupton, 60 feet at Platteville, and 86 feet at Evans; 100 miles still east, at Sterling, Colo., water is 4 to 20 feet from the surface, in sand and gravel. The gravel there is much smaller than at other localities named, and there is more quicksand above it.

The amount of water that may be stored in a cubic foot of sand or gravel, when fully saturated, has been ascertained by careful experiment to be as follows: Fine sand 2 gallons, coarse sand 2½ gallons, sand and fine gravel 3 gallons, coarse gravel and small stones the size of hen's eggs 3.6 gallons. As a cubic foot contains 7.5 American gallons, it will be seen that very large gravel beds contain fully one-half water. Water is found in all the dry creeks and the valleys adjacent thereto in northern Colorado, east of the mountains, at varying depths from 2 to 20 feet. Actual tests have been made verifying this matter on Lone Tree, Big Crow, Little Crow, Wild Cat, Pawnee, Lewis, and Cedar Creeks north of the South Platte River, and on Cherry Creek, Sand Creek, Lost Creek, Box Elder, Kiowa, Bijou, Big Beaver, and Little Beaver south of this river. As investigation goes on, the area of land known to have underground reservoirs of water at a nominal depth from the surface is largely increased.

In twenty counties in Colorado, lying east of the base line, which runs through Pueblo, there are some 25,000,000 acres of land. Fully 20,000,000 acres of this is suitable for cultivation, and probably one-fourth of this, or 5,000,000 acres, are underlaid with an ample water supply near the surface, available for use for irrigation by mechanical power—that by lifting or pumping.

A major part of the water from the eastern slope of the mountains, in the South Platte River and its tributaries, taken for irrigation, is used west of this line. From a residence in this locality of seventeen years, and a close connection practically with the operation of ten large irrigating ditches, I believe there is a loss of fully 40 per cent. of the water between the heads of irrigation canals and the application of the water to the lands at varying distances along the line of distribution. The Colorado State engineer, it is understood, testified in Denver that there was in use for this season's irrigation about 1 cubic foot of water per second for each 342 acres of land cultivated in the State—about one-fourth the amount actually needed. This accounts for the large loss in the later crops of potatoes, alfalfa, etc. If all the water in the natural streams on the eastern slope of the mountains in Colorado be stored in reservoirs and used in this State, it will no more than fairly irrigate the land lying under the present irrigating canals, as fully one half the land under said canals in the State is not in cultivation at the present time. Attention is called to the testimony given as to the condition of the water supply in the lower part of the Rio Grande and Rio Pecos, also in the lower Arkansas Valley. The same condition exists, and to a greater degree, in the lower South Platte Valley, where a greater de-

velopment has been made in farming by irrigation. This condition of a shortage of water supply in the lower valleys increases every year even with the construction of reservoirs by private capital each season.

Careful investigation in Arapahoe and Jefferson Counties indicate that as much more land as is now cultivated can be watered by mechanical power. The average depth to water on the bottom-lands is about 8 feet; on second bottom-lands 20 feet, and the supply seems inexhaustible. In dry gulches and sand creeks the depth to water is from 2 to 12 feet. Lump coal, near Denver, costs about $5 per ton; slack coal, about $1.25 per ton retail, and 90 cents per ton in car lots. These facts are necessary in estimating the cost of pumping.

In Rio Grande, Saguache, Conejos, Costilla, Huerfano and Las Animas Counties, Colorado, estimates are made that 300,000 acres can be reclaimed by such mechanical power, and not otherwise. There is much waste land in these counties. The depth to water averages from 6 to 25 feet, and the supply seems enormous, entire rivers and creeks flowing into the sand, and being lost for surface irrigation. Fuel is plentiful and cheap in these counties, coal costing from $1 to $6 per ton, according to locality.

In New Mexico it is estimated that 1,500,000 acres can be reclaimed by mechanical power. There is much waste land in this Territory. The depth to water is usually from 10 to 50 feet, and the supply of water near the surface seems very large. Fuel is plentiful, and usually cheap. Coal costs from $1 to $6 per ton. Mesquite is used for fuel in some localities. Letters from the States and Territories in the arid West indicate a very large area of land that can be reclaimed only by mechanical power in elevating water for irrigation. The conditions of such use would vary, and can be named, as follows:

(1) Where irrigation is not much developed, and where capital is not readily interested in large irrigation enterprises.

(2) Where the streams having an ample surface water supply are sluggish, and run on a grade of from 2 to 5 feet per mile; also, in elevating water from lakes, where the land adjacent thereto is in broad and comparatively level valleys, as at Utah Lake, in Utah, and Tulare Lake, California.

(3) Where the streams run deep in the ground at all stages, and the agricultural lands adjoining are on mesas, at varying heights of from 20 to 100 feet.

(4) Where the level of water in running streams varies greatly at flood tide and low water, the valleys being narrow and the streams tortuous. (This condition necessitates the construction of small irrigation ditches. The fall of water in the streams, later in the season, leaves these ditches high above water.)

(5) In the lower valleys of the larger streams, like the South Platte, Arkansas, and Rio Grande, where the water is all used in upper ditches for the lands adjacent thereto.

(6) In many parts of the arid district, where there are no running streams on the surface, but where the under-flow from lost rivers and creeks, or the general under-drainage of storm-waters and mountain streams gives an ample supply near the surface.

FURTHER STATEMENT OF BENJAMIN H. EATON.

The CHAIRMAN. Do you wish to add anything to what you said this morning?

Mr. EATON. Yes. There seems to be a misunderstanding as to the increase of our water supply. By reservoirs and canals the whole of the Poudre River is held back. There is no doubt but that it is flowing a little more every year. One gentleman here said there was no more water than is enough to irrigate the land under cultivation. I know as much about it as he does, though I do not pretend to know any more. I built these ditches and I built the upper end of No. 2, and 5 miles out I dug a well 35 feet deep and could not get water to supply my camp. Now the water is running on the surface. Mr. La Grange dug down, I think, 33 feet before he got any water. You can now dip the water out of his well with a cup.

This Larimer & Weld canal is 50 miles long, and I tried at one time to get water along its line, but could not get it. I hired a man to dig wells along there and he did not find water. In this flat country that we have made these ditches over there is not any "wash" to amount to anything. There is a deposit. The earth above the hard pan that retains the water is from 50 to 60 feet. At Eaton at one time we dug 25 feet for water. Now it is only 15 feet to water. A seepage ditch, holding only the accumulated water of 3 miles, was sold for $5,000. I think it was worth double that sum.

By holding this water back, with the flow toward the east, it can not help but increase the irrigation to the extent of the water we have. After irrigation there comes seepage streams, and to my mind it will never be known to us how much water there is.

Senator TELLER. I would like to have the record show that Governor Eaton is a practical farmer.

The CHAIRMAN. Please state how much land you farm.

Mr. EATON. Eight thousand acres, by renting and what I farm myself.

Senator TELLER. You overlook and attend in all to 8,000 acres?

Mr. EATON. Yes.

Senator TELLER. That gives you a good opportunity to observe.

Mr. EATON. Yes.

STATEMENT OF B. S. LA GRANGE, OF GREELEY.

The CHAIRMAN. What is your occupation?

Mr. LA GRANGE. My original occupation is farming. I am also water commissioner on the Caché la Poudre. My principal occupation at present is water commissioner; distributing water in that district.

The CHAIRMAN. How long have you been engaged in agriculture in this vicinity?

Mr. LA GRANGE. Nineteen years.

The CHAIRMAN. What do you say is the duty of water? That is, what quantity of water is required in Greeley and vicinity to produce ordinary crops?

Mr. LA GRANGE. From 60 to 100 cubic feet per second per 80 acres for the season. I might explain why I make that difference of "60 to 100." Our soil is so variable that in the different localities even on the same farm there is a vast difference in the duty of water. Where we

have a soil that is 60 per cent. sand it takes more water to do duty in growing the crop than it does when the soil has a less quantity of sand.

The CHAIRMAN. Is that much water used and consumed in plant growth and evaporation?

Mr. LA GRANGE. To some extent.

The CHAIRMAN. Is it all used?

Mr. LA GRANGE. No.

The CHAIRMAN. What proportion is not consumed and what becomes of the water that is not so consumed?

Mr. LA GRANGE. The earth becomes infiltrated with it.

The CHAIRMAN. Does it show itself anywhere?

Mr. LA GRANGE. It shows itself along the margins of the streams, when it is returned to the streams again.

The CHAIRMAN. What has it produced along the margins of streams?

Mr. LA GRANGE. Increased soil.

The CHAIRMAN. Has it produced swamps?

Mr. LA GRANGE. I do not know exactly the acreage along our irrigation district.

The CHAIRMAN. I am not asking for exact acreage, but whether there is more or less swamp ground on the lower bottoms in consequence of irrigation?

Mr. LA GRANGE. On the Caché la Poudre it goes pretty nearly the entire length of the interval lands along the bottoms. Wherever irrigation is practiced, there is found made soil.

The CHAIRMAN. The low bottoms nearly the whole length are mud swamps.

Mr. LA GRANGE. Yes.

The CHAIRMAN. What is necessary to reclaim them?

Mr. LA GRANGE. Drainage.

The CHAIRMAN. Does this drainage furnish any accumulation of water that could be used for further irrigation?

Mr. LA GRANGE. It does.

The CHAIRMAN. How does the seepage from the water that is not consumed by irrigation show in the stream?

Mr. LA GRANGE. By an increased supply in the stream below.

The CHAIRMAN. How does the Caché la Poudre compare below Greeley, say 5 miles, with what it was before any water was taken out and used, during the dry season, I mean?

Mr. LA GRANGE. We have measured it, and the quantity of water is increased 87 cubic feet per second in the very dry season. It is so today.

The CHAIRMAN. It has increased in the stream below the irrigation?

Mr. LA GRANGE. Yes.

The CHAIRMAN. How far down does that increase manifest itself?

Mr. LA GRANGE. About 2½ miles below Greeley, according to our last observations.

The CHAIRMAN. There is more water in the Caché la Poudre below the irrigated district in the dry season than there was before irrigation commenced there?

Mr. LA GRANGE. Yes.

The CHAIRMAN. How is it as to the water coming to the surface; is the country irrigated nearer the surface than when you began irrigating?

Mr. LA GRANGE. It is.

The CHAIRMAN. How much nearer? How deep did you have to dig before irrigation commenced, and how deep do you have to dig now?

Mr. LA GRANGE. It formerly varied from 12 to 40 feet. In the case of some of the old original wells, where it was 12 or 16 feet deep, you can now take water out with a bucket in your hand?

The CHAIRMAN. Then the earth has become filled with water?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Does it require as much water to irrigate, now that the earth is saturated, as it did then?

Mr. LA GRANGE. Not so much in some places, but in others about the same.

The CHAIRMAN. No as much as you did the first year, of course?

Mr. LA GRANGE. No.

The CHAIRMAN. Commencing with perhaps about the third year, there are some places that have not decreased the amount required, and some places that have, even since then?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Are they still decreasing the amount required each year?

Mr. LA GRANGE. Yes.

The CHAIRMAN. What is your mode of distributing the water when there are various persons interested?

Mr. LA GRANGE. We take the cubic foot as the unit of measure, and, under our laws, priority of appropriation gives the better right. There is decreed to each canal the amount of water necessary to be used upon the land.

The CHAIRMAN. Then you distribute the necessary amount of water according to the date of priority?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Have you adopted the plan of giving a certain amount, or giving on certain days, to one and then to another?

Mr. LA GRANGE. Yes; notwithstanding the priority of appropriation, our people are so educated to the necessity of having service that they have left it to the commissioner to so rotate the water so as to get the highest duty and best service.

The CHAIRMAN. State how that will effect a better service.

Mr. LA GRANGE. By running it on the plan of priority of appropriation strictly the water becomes lost, because our canals are of such great length that the amount appropriated for one canal is lost along the line.

By "bunching the canals," as it is called, we get a sufficient head to get a better duty.

The CHAIRMAN. That is, you get a sufficient amount of water to run down the ditch and do some good?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Whereas, if you distributed the water by priority, a ditch company would not have enough to do any good and yet would consume a great deal of water?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Would it not be much more economical if there were just two ditches, one on each side of the river, and no more, to carry the water and distribute it?

Mr. LA GRANGE. Yes; that is one of the troubles of our early settlement.

The CHAIRMAN. Too many ditches?

Mr. LA GRANGE. Too many ditches.

The CHAIRMAN. That wastes a great deal of water.

Mr. LA GRANGE. Certainly. We have an illustration at Fort Collins. We have 16,000 acres there in cultivation. There are four lines of ditches running across. Two of them are nearly parallel, and in some cases these are not 200 feet apart. We have another up in the foot-hills.

The CHAIRMAN. All should have been carried to the upper ditch, you think?

Mr. LA GRANGE. We could not very well have carried them to that ditch to get the best service. It is too high up, and we would have had to have two great lines of distributing mains along down. But it should have been differently arranged in the first instance.

The CHAIRMAN. The economy of water depends a good deal on having ditches located in the right place and carrying the water in the fewest number of ditches?

Mr. LA GRANGE. Yes, that is one of the troubles we have. We have too many ditches for the area of land.

The CHAIRMAN. What is the best grade for a ditch?

Mr. LA GRANGE. It depends on the character of the soil.

The CHAIRMAN. How is it in your locality?

Mr. LA GRANGE. It depends there, too, upon the character of the soil. From 2 to 4 feet to the mile on the average.

The CHAIRMAN. That depends something on the size of the ditch, too, does it not?

Mr. LA GRANGE. Yes; about 3 feet to the mile is about right?

The CHAIRMAN. In your small ditches or in the large ones.

Mr. LA GRANGE. In the large ones.

The CHAIRMAN. That is ample?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Does it "wash?"

Mr. LA GRANGE. Yes, in some localities, but not in other places. The usual grade on the large canals is about 2.40 feet per mile.

The CHAIRMAN. Is there much of the water wasted?

Mr. LA GRANGE. Yes. The American people are all new to the subject of irrigation, and have not arrived at that stage of nice preparation of our soils with reference to getting at the highest duty of water. I am aware of this fact: That in Caché la Poudre Basin we could do double the duty of water with our present flow, taking an average of five or six years.

The CHAIRMAN. Without storage or anything else of that sort?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Merely by economic use?

Mr. LA GRANGE. Yes, merely by economic use.

The CHAIRMAN. With storage, then, you could increase that still further. Could you not do that by saving the waste water from running off?

Mr. LA GRANGE. We have, on that water-shed, been taking observations now for six years, and with a storage systematized in a proper way we could treble our irrigation.

The CHAIRMAN. How much land have you there?

Mr. LA GRANGE. About 225,000 acres irrigated.

The CHAIRMAN. With economy of water, without storage, could that be increased?

Mr. LA GRANGE. Nearly double.

The CHAIRMAN. With storage how much could it be increased?

Mr. LA GRANGE. I am satisfied that with the proper storage system we could readily irrigate from 600,000 to 800,000 acres.

The CHAIRMAN. Of course that would involve having proper ditches and economizing the water?

Mr. LA GRANGE. Yes.

The CHAIRMAN. Is it better to irrigate near the mountains than far away on the plains?

Mr. LA GRANGE. It is better to get near the mountains.

The CHAIRMAN. Why?

Mr. LA GRANGE. On account of the loss, by escape, in the transportation such a very long distance.

The CHAIRMAN. What produces the loss?

Mr. LA GRANGE. Filtration, principally.

The CHAIRMAN. What else?

Mr. LA GRANGE. Evaporation to some extent, but that is comparatively small.

The CHAIRMAN. What is the loss in a ditch of the size you have there?

Mr. LA GRANGE. We have 35-feet ditches.

The CHAIAMAN. That is, 35 feet on the bottom?

Mr. LA GRANGE. Yes.

The CHAIRMAN. How deep?

Mr. LA GRANGE. From 5 to 6 feet.

The CHAIRMAN. With a fall of from 2.40 feet to 3 feet to the mile, what would be the probable loss of running water in a ditch over that country, say 20 miles?

Mr. LA GRANGE. From 15 to 25 per cent. It depends upon the kind of soil we are running over.

The CHAIRMAN. You think it would make that difference in 20 miles of length?

Mr. LA GRANGE. I think I would make the distance 40 miles.

Director POWELL. Suppose you should change the section of your ditches in this country, what would the effect be? You have wide and shallow ditches which require a great declivity—a high grade. Suppose you change that and have a rounded bottom instead of a flat bottom, and increase the depth of your ditches two or three fold, what effect would that have on the conservation of the water?

Mr. LA GRANGE. If the conditions of the water were all the same as they are now, it would decrease the loss and get a more rapid discharge at the end of the ditch, or at any given point along it. But after we have made these flat bottoms, by use they get a subgrade fixed by themselves.

Director POWELL. They cut out themselves?

Mr. LA GRANGE. Yes.

The CHAIRMAN. They cut out and round out.

Mr. LA GRANGE. Yes; nature always fixes those things.

Director POWELL. When you open your ditches at the commencement of the irrigating season—that is, each time you open them—a large body of water is absorbed before the water can get to the foot of the ditch. Is that not the fact?

Mr. LA GRANGE. It is.

Director POWELL. Have you anything to suggest as to how that loss could be prevented?

Mr. LA GRANGE. I could not suggest anything now as to that. The percentage of loss will vary more or less in accordance with the head that you put in at the time. When I want to let water down through the ditch, to be let out by the main stream, I get the ditch two-thirds

full; that will run through in thirty hours, whereas, if I take half of that quantity it will be possibly sixty hours. That percentage of loss will vary according to the size of the head and the condition of the ditch. It varies also with the seasons. Atmospheric conditions have much to do with it.

Director POWELL. Have you, in your community, ever thought of lining your ditches by silting with gypsum or any heavy material which would be impervious to water?

Mr. LA GRANGE. We will do that when we get better off, and get a more dense population, so that we can stand it.

Director POWELL. I mean lining by silting and not by masonry.

Mr. LA GRANGE. I understand. When we first put the water in the Caché la Poudre, No. 2 ditch, in 1872, it ran down 6 miles and sunk. It ran very nearly a week. Our mountain streams, when rising, bring down a vast amount of stuff caused by erosion and it silts the ditch. The ditches do silt up and become comparatively tight.

Director POWELL. You have a very great variety of material in your region. Have your people thought of some material which you could powder and float down, which would have that same effect, only to do the thing more thoroughly?

Mr. LA GRANGE. Yes; we have large bodies of gypsum right near Fort Collins and north of there, which if powdered up and properly applied to our canals would prevent large wastage of water, just the gypsum itself.

The CHAIRMAN: How do you communicate with the different points where the water is to be let out?

Mr. LA GRANGE. We have a man at the head-gate, and he is in communication by telephone with the central office. That system is now about completed.

The CHAIRMAN. What are the advantages of that?

Mr. La GRANGE. In order to distribute the water, we must know what definite quantity we have to deal with, so we telephone to the head-gate man.

Adjourned.

CONSTITUTION AND LAWS OF COLORADO—PROVISIONS RELATING TO WATER RIGHTS.

PRIORITIES AND RIGHTS THEREUNDER.

[Constitution, Art. XVI.]

Sec. 5. Water Public Property.]

The water of every natural stream not heretofore appropriated, within the State of Colorado, is hereby declared to be the property of the public, and is dedicated to the use of the people of the State, subject to appropriation as hereinafter provided.

Sec. 6. Diverting Unappropriated Water—Priority.]

The right to divert unappropriated waters of every natural stream for beneficial uses shall never be denied. Priority of appropriation shall give the better right, as between those using the water for the same purpose; but when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall have the preference over those claiming for any other purpose, and those using the water for agricultural purposes shall have the preference over those using the same for manufacturing purposes.

RIGHT OF WAY AND SERVITUDE.

Art. II, Sec. 14. When Private Property may be taken for Private Uses.]

Private property shall not be taken for private use unless by consent of the owner, except for private ways of necessity, and except for reservoirs, drains, flumes, or ditches, on or across the lands of others, for agricultural, mining, milling, domestic, or sanitary purposes.

Art. II, Sec. 15. Compensation for Property taken.]

Private property shall not be taken or damaged for public or private use without just compensation. Such compensation shall be ascertained by a board of commissioners of not less than three freeholders, or by a jury when required by the owner of the property, in such manner as may be prescribed by law, and until the same shall be paid to the owner, or into court for the owner, the property shall not be needlessly disturbed, or the proprietary rights of the owner therein invested [divested]; and whenever an attempt is made to take private property for a use alleged to be public, the question whether the contemplated use be really public shall be a judicial question, and determined as such without regard to any legislative assertion that the use is public.

Art. XVI, Sec. 7. Right of Way for Ditches, etc.]

All persons and corporations shall have the right of way across public, private, and corporate lands for the construction of ditches, canals, and flumes, for the purpose of conveying water for domestic purposes, for the irrigation of agricultural lands, and for mining and manufacturing purposes, and for drainage, upon payment of just compensation.

Art. XVI, Sec. 8. County Commissioners fix Rates for Water.]

The general assembly shall provide by law that the board of county commissioners in their respective counties shall have power, when application is made to them by either party interested, to establish reasonable maximum rates to be charged for use of water whether furnished by individuals or corporations.

Art. X, Sec. 3. When Free from Taxation.]

Ditches, canals, and flumes owned and used by individuals or corporations for irrigating lands owned by such individuals or corporations, or the individual members thereof, shall not be separately taxed so long as they shall be owned and used exclusively for such purposes.

WATER AND IRRIGATION PROVISIONS IN STATUTES OF COLORADO.

General Statutes, 1711, (1861). Owners of Land on Streams Entitled to Use of Water.]

All persons who claim, own, or hold a possessory right or title to any land or parcel of land lying within the boundary of the State of Colorado, as defined in the constitution of said State, when those claims are on the bank, margin, or neighborhood of any stream of water, creek, or river, shall be entitled to the use of the water of said stream, creek, or river, for the purpose of irrigation and making said claims available to the full extent of the soil, for agricultural purposes.

1729. Vested Rights of Mill and Ditch Owners.]

Nothing in this chapter contained shall be so construed as to impair the prior vested rights of any mill or ditch owner or other person to use the water of any such water course.

Under the provisions of this act [*eminent domain*] private property may be taken for private use for private ways of necessity, for reservoirs, drains, flumes, or ditches on or across the land of others for agricultural, mining, milling, domestic, or sanitary purposes. (Session Laws of 1885, pp. 201, 202.)

PRIORITY—HOW SECURED.

1720. New Ditches—Sworn statement must be filed—Contents—Maps.]

Every person, association, or corporation hereafter constructing or enlarging any ditch, canal, or feeder for any reservoir, for irrigation, and taking water directly from any natural stream, and of a carrying capacity of one cubic foot per second of time, as so constructed or enlarged, shall within ninety days after the commencement of such construction or enlargement, file and cause to be recorded in the office of the

county clerk of the county in which such ditch, canal, or feeder may be situated, or if such canal, ditch, or feeder be situated in any water district, in the office of the county clerk of such [each] county in which such water district may extend, a sworn statement in writing, showing the name of such ditch, canal, or of the reservoir supplied by such feeder, the point at which the head-gate thereof is situated (if it be a new construction), the size of the ditch, canal, or feeder, in width and depth, and the carrying capacity thereof in cubic feet per second, the description of the line thereof, and the time when the work was commenced, and the name or names of the owner or owners thereof, together with a map showing the route thereof, the legal subdivisions of the land, if on surveyed lands, with proper corners and distances, and in case of an enlargement, the depth and width, also the carrying capacity of the ditch enlarged, with the width and depth of the ditch, canal, or feeder as enlarged, and the increased carrying capacity of the same thereby occasioned, and the time when such enlargement was commenced, and no priority of right for any purpose shall attach to any such construction or enlargement until record is made. (Sec. 2, p. 162, acts 1881.)

1721.]

This act shall apply to and affect only ditches, canals, or feeders used for carrying water for the purposes of irrigation and for no other purposes whatever. (Sec. 3, p. 162, Acts 1881.)

314. Shall Commence Work in Ninety Days—Complete in Three Years—Forfeit.]

Any company formed under the provisions of this (corporations) act, for the purpose of constructing any ditch, flume, * * * shall, within ninety days from the date of their certificate, commence work on such ditch, flume * * * line as shall be named in the certificate, and shall prosecute the work with due diligence until the same is completed, and the time of completion of any such ditch * * * line shall not be extended beyond a period of two years from the time work was commenced as aforesaid; and any company failing to commence work within ninety days from the date of the certificate, or failing to complete the same within two years from the time of commencement as aforesaid, shall forfeit all right to the water so claimed, and the same shall be subject to be claimed by any other company; the time for the completion of any flume constructed under the provisions of this act shall not be extended beyond a period of four years: *Provided*, This section shall not apply to any ditch or flume * * * constructed through and upon any grounds owned by the corporation: *And provided further*, That any company formed under the provisions of this act to construct a ditch for domestic, agricultural, irrigating * * * purposes, or any or either thereof, shall have three years from the time of commencing work thereon within which to complete the same, but no longer. (Sec. 296 (106) pp. 179–80, G. L.)

1727. Wheels, etc., on Streams.]

All persons on the margin, brink, neighborhood, or precinct of any stream of water shall have the right and power to place upon the bank of said stream a wheel or other machine for the purpose of raising water to the level required for the purpose of irrigation. (Sec. 8, pp. 68–69, Acts 1861; sec. 6, p. 364, R. S.; sec. 1377 (6) p. 516, G. L.)

1723. Irrigation of Meadows.]

All persons who shall have enjoyed the use of the water in any natural stream, for the irrigation of any meadow land, by the natural overflow or operation of the water of such stream, shall, in case the diminishing of the water supplied from such stream from any cause prevents such irrigation therefrom in as ample a manner as formerly, have right to construct a ditch for the irrigation of such meadow, and to take water from such stream therefor, and his, her or their right to water through such ditch shall have the same priority as though such ditch had been constructed at the time he, she or they first occupied and used such land as meadow ground. (Sec. 37, p. 106, Acts 1879.)

1719. Extending Head of Ditch Up Stream.]

In case the channel of any natural stream shall become so cut out, lowered, turned aside or otherwise changed from any cause as to prevent any ditch, canal, or feeder of any reservoir from receiving the proper inflow of water to which it may be entitled from such natural stream, the owner or owners of such ditch, canal, or feeder shall have the right to extend the head of such ditch, canal, or feeder to such distance up the stream which supplies the same, as may be necessary for securing a sufficient flow of water into the same, and for that purpose shall have the same right to maintain proceedings for condemnation of right of way for such extension as in case of constructing a new ditch, and the priority of right to take water from such stream through such ditch, canal, or feeder, as to any such ditch, canal, or feeder, shall remain unaffected in any respect by reason of such extension: *Provided, however*, That no such extension shall interfere with the complete use or enjoyment of any other ditch, canal, or feeder. (Sec. 1, pp. 161, 162, Acts 1881.)

1762. Jurisdiction of Courts. How Vested.]

For the purpose of hearing, adjudicating, and settling all questions concerning the priority of appropriation of water between ditch companies and other owners of ditches drawing water for irrigation purposes from the same stream or its tributaries within the same water district, and all other questions of law and questions of right growing out of or in any way involved or connected therewith, jurisdiction is hereby vested exclusively in the district court of the proper county; but when any water district shall extend into two or more counties, the district court of the county in which the first regular term after the first day of December in each year shall soonest occur, according to the law then in force, shall be the proper court in which the proceedings for said purpose, as hereinafter provided for, shall be commenced; but where said proceedings shall be once commenced, by the entry of an order appointing a referee in the manner and for the purpose hereinafter in this act provided, such court shall thereafter retain exclusive jurisdiction of the whole subject until final adjudication thereof is had, notwithstanding any law to the contrary now in force. (Sec. 19, pp. 99–100, Acts 1879.)

1763. Filing Statements of Claim—Ditch, Name, Description—Post-Office Address.]

In order that all parties may be protected in their lawful rights to the use of water for irrigation, every person, association, or corporation owning or claiming any interest in any ditch, canal, or reservoir, within any water district, shall, on or before the 1st day of June, A. D. 1881, file with the clerk of the district court having jurisdiction of priority of right to the use of water for irrigation in such water district, a statement of claim, under oath, entitled of the proper court, and in the matter of priorties of water rights in district number * * * , as the case may be, which statement shall contain the name or names, together with the post-office address of the claimant or claimants claiming ownership, as aforesaid, of any such ditch, canal, or reservoir, the name thereof (if any), and, if without a name, the owner or owners shall choose and adopt a name, to be therein stated, by which such ditch, canal, or reservoir shall thereafter be known, the description of such ditch, canal, or reservoir, as to location of head-gate, general course of ditch, the name of the natural stream from which such ditch, canal, or reservoir draws its supply of water, the length, width, depth, and grade thereof, as near as may be, the time, fixing a day, month and year as the date of the appropriation of water by original construction, also by any enlargement or extension, if any such thereof may have been made, and the amount of water claimed by or under such construction, enlargement, or extension, and the present capacity of the ditch, canal, or feeder of reservoir, and also the number of acres of land lying under and being or proposed to be irrigated by water from such ditch, canal, or reservoir. Said statement shall be signed by the proper party or parties. (Sec. 1, pp. 142, 143, Acts 1881.)

1764. Secretary of State Shall Make Publication—Publisher's Certificate.]

The secretary of state shall, without delay, after the passage of this act, cause a certified copy of the foregoing section, giving the date of the approval of this act, to be published in one of the public newspapers published in such county in which part or portion of any water district is or shall be established by law at the time of such publication; and said section 1 shall be published, as aforesaid, once in each and every week continuously in said paper until said 1st day of June, 1881, and in case in the meantime any one of said papers shall cease to be published, then such publication shall be made in some other paper in same county (if any), and on conclusion of such publication such publisher of such paper shall deliver to the secretary of state his sworn certificate of publication in duplicate, showing that such publication has been made in his paper in compliance with the preceding section hereof, and stating the first and last day of such publication; and he shall thereupon be entitled to receive from the secretary of state a certificate of the amount due him for such publication, on presentation of which to the auditor of state he shall draw his warrant for the amount in favor of the holder on the state treasurer, who shall pay the same according to law. (Sec. 2, pp. 143, 144, Acts 1881.)

When at any time after the 1st day of June, A. D. 1881, any one or more persons, associations, or corporations, interested as owners of any ditch, canal, or reservoir in any water district shall present to the district court of any county having jurisdiction of priority of rights to the use of water for irrigation in such water district according to the provisions of (sec. 19, G. S., 1762) an act entitled an act to regulate the use of water for irrigation and providing for settling the priority of rights thereto, and for payment of the expenses thereof, and for payment of all costs and expenses incident to said regulation of use, or to the judge thereof in vacation, a motion, petition, or application in writing, moving or praying said court to proceed to an adjudication of the priorities of rights to use of water for irrigation between the several ditches, canals, and reservoirs in such district, the court, or judge thereof in vacation, shall, without unnecessary delay, in case he shall deem it practicable to proceed in open court, as prayed for, by an order to be entered of record upon such mo-

tion, petition, or application, appoint a day in some regular or special term of said court for commencing to hear and take evidence in such adjudication, at which time it shall be the duty of the court to proceed to hear all evidence which may be offered by or on behalf of any person, association, or corporation interested in any ditch, canal, or reservoir in such district, either as owner or consumer of water therefrom, in support of or against any claim or claims of priority of appropriation of water made by means of any ditch, canal, or reservoir, or by any enlargement or extension thereof, in such district, and consider all such evidence, together with any and all evidence, if any, which may have been heretofore offered and taken in such district in the same matter by any referee heretofore appointed under the provisions of said act above herein mentioned, and also the arguments of parties or their counsel, and shall ascertain and find from such evidence, as near as may be, the date of the commencement of such ditch, canal, or reservoir, together with the original size and carrying capacity thereof as originally constructed, the time of the commencement of each enlargement or extension thereof, if any, with the increased capacity thereby occasioned, the time spent severally in such construction and enlargement, or extension and re-enlargement, if any, the diligence with which the work was in each case prosecuted, the nature of the work as to difficulty of construction, and all such other facts as may tend to show the compliance with the law, in acquiring the priority of right claimed for each such ditch, canal, or reservoir, and determine the matters put in evidence, and make and cause to be entered a decree determining and establishing the several priorities of right, by appropriation of water, of the several ditches, canals, and reservoir [reservoirs] in such water district, concerning which testimony shall have been offered, each according to the time of its said construction and enlargement or enlargements or extensions, with the amount of water which shall be held to have been appropriated by such construction and enlargements or extensions, describing such amount by cubic feet per second of time, if the evidence shall show sufficient data to ascertain such cubic feet, and if not, by width, depth, and grade, and such other description as will most certainly and conveniently show the amount of water intended as the capacity of such ditch, canal, or reservoir, in such decree. Said court shall further order that each and every party interested or claiming any such ditch, canal, or reservoir shall receive from the clerk, on payment of a reasonable fee therefor, to be fixed by the court, a certificate under seal of the court showing the date or dates and amount or amounts of appropriations adjudged in favor of such ditch, canal, or reservoir under and by virtue of the construction, extension, and enlargements thereof severally; also specifying the number of said ditch and of each priority to which the same may be entitled by reason of such construction, extension, and enlargements. (Sec. 4, pp. 144–5–6, Acts 1881.)

1767. Copy of Decree—Authority of Commissioner—Recording Copy—Evidence.]

The holder of such certificate shall exhibit the same to the water commissioner of the district when he commences the exercise of his duties, and such water commissioner shall keep a book in which shall be entered a brief statement of the contents of such certificate, and which shall be delivered to his successor, and said certificate, or statement thereof in his book, shall be the warrant of authority to said water commissioner for regulating the flow of water in relation to such ditch, canal, or reservoir. Said certificate shall be recorded, at the same rates of charges as in cases of deeds of conveyance, in the records of each county into which the ditch, canal, or reservoir to which such certificates relates shall extend; and said certificate, or said record thereof, or a duly certified copy of such record, shall be prima facie evidence of so much of said decree as shall be recited therein in any suit or proceeding in which the same may be relevant. (Sec. 5, pp. 146–7, Acts 1881.)

1768. Clerk Publish Notice—Post Copy—Ten Copies Posted by Party Petitioning.]

Notice shall be given by the clerk of said court of the time so appointed by publishing the same in one public newspaper in such county into which such water district may extend, which notice shall be so published in such paper once in each week until four successive weekly publications shall have been made, the last of which shall be on a day previous to the day appointed as aforesaid. Said notice shall contain a copy of said order, and shall notify all persons, associations, and corporations interested as owners in any ditch, canal, or reservoir in such water district to appear at said court at the time so appointed and file a statement of claim under oath, in case no statement has been before filed by him, her, or them, showing the ditch, canal, or reservoir, or two or more such, in which he, she, or they claim an interest, together with the names of all the owners thereof, which statement may be made by any one of the owners of such ditch, canal, or reservoir for and in behalf of all; and also that all persons interested as owners or consumers may then and there present his, her, or their proofs for or against any priority of right of water by appropriation sought to be shown by any party by or through any such ditch, canal, or reservoir (either as owner or consumer of water drawn therefrom). Ten printed copies of said notice shall also

be posted in ten public places in such water district not less than twenty days before the day so appointed, which copies shall be so posted by the party or parties moving the adjudication. (Sec. 6, p. 147, Acts 1881.)

1769. Proof of Publication—Of Posting Copies—Entry by Clerk.]

Proof of the proper publication of said notice or notices in said public papers shall consist in such case of the sworn certificate of the publisher of such newspaper, showing the publication to have been made in accordance with the provisions of section 3 of this act, which certificates shall be procured by the party or parties moving the adjudication at his or their expense, and on said certificate being filed the clerk shall enter the amount of the printer's fee therefor as costs advanced by the party procuring the same, which sum shall be counted to his, her, or their credit in distribution of costs. Proof of the posting of said printed copies shall be made by the affidavit of some credible person, certified to be such by the clerk or other officer administering the oath, showing when, where, and how said copies were posted. (Sec. 7, pp. 147-8, Acts 1881.)

1770. Notices Served on all Parties—How Served—Notice by Mail.]

The party or parties moving such adjudication shall cause a printed or written copy of the notice aforesaid, published as aforesaid, to be served on every person, association, or corporation shown by the statement of claim on file, as provided in section 1 hereof, which service shall be made within ten days from the time of the first publication by the clerk, by any credible person certified by said clerk or referee to be such, by delivering such copy as aforesaid to the person to be served, if such person by due diligence can be found in the county of his residence. If such person can not be found, as aforesaid, then by leaving such copy at his or her usual place of residence, if he or she have such residence, in charge of some person of the age of fourteen years or over there residing; and on any corporation by delivering the copy to the president, or vice-president, or secretary, or treasurer thereof, or the manager or superintendent in charge of their ditch, canal, or reservoir, or authorized agent or attorney, or by leaving such copy at the office or usual place of business of such corporation, and the proof of such service shall be made by affidavit of the person or persons serving said copies, showing when and how such service has been made on such party. In case of parties not served in any manner as aforesaid the clerk shall deposit in the post-office, duly inclosed in an envelope with the proper postage stamp thereon, a copy directed to the address of such party, shown in the statement of claim aforesaid, filed by him or her under section one hereof. (Sec. 8, pp. 148–9, Acts 1881.)

1771. Court Numbers all Ditches—Reservoirs—Number Appropriations.]

The court, in making such decree, as aforesaid, shall number the several ditches and canals in the water district concerning which adjudication is made in consecutive order, according to priority of appropriation of water thereby made by the original construction thereof, as near as may be, having reference to the date of each decree as rendered, and shall also number the reservoirs in like manner separately from ditches and canals, and shall further number each several appropriation of water consecutively, beginning with the oldest appropriation, without respect to the ditches or reservoirs by means of which such appropriations were made; whether such appropriation shall have been made by means of construction, extension, or enlargement, which number of each ditch, canal, or reservoir, together with the number or numbers of any appropriations of water held to have been made by means of the construction, extension, or enlargement thereof, shall be incorporated in said decree and certificate of the clerk, to be issued to the claimants, as provided in section 1 of this act, so as to show the order in priority of such ditch or canal; and of such reservoir, and also of such successive appropriation of water pertaining thereto, for the information of the water commissioner of the district in distributing water, such numbering to be as near as may be having reference to date of decrees as rendered. (Sec. 9, p. 149, Acts 1881.)

1772. When Court may Appoint Referee—What Referred.]

If for any cause the judge of said court shall deem it impracticable or inexpedient to proceed to hear such evidence in open court, he shall, instead of the order mentioned in section 4 of this act, make and cause to be entered of record an order appointing some discreet person, properly qualified, a referee of said court, to whom shall be referred the statement of claim aforesaid on file in said matter, the matter of taking evidence and reporting the same, making an abstract and findings upon the same, and preparing a decree in said adjudication; and also in case of any water district in which a referee has been heretofore appointed, and evidence taken by him under the provisions of the act, the title of which is recited in section 4 of this act; such

evidence so already taken, together with the abstract thereof and report of the referee who took the same, shall be also referred to said referee, to be appointed as aforesaid, and he shall proceed with his duties as hereinafter provided, first taking an oath [of] office, such as is required to be taken by referees in other cases under the provisions of the code of civil procedure. (Sec. 10, pp. 149-50, Acts 1881.)

1773. Contents of Notice—How Published—Posting Copies.]

Said referee shall prepare and publish a notice containing a copy of the order appointing him, in which notice he shall appoint a time or times and place or places suitable and convenient for the claimants in such water district at which he will attend for the purpose of hearing and taking evidence touching the priority of right of the several ditches, canals, and reservoirs in said district, and notifying all persons, associations, and corporations interested as owners or consumers of waters [water] to attend by themselves, their agents, or attorneys, at the times and places appointed in said notice, and notifying such owners to then and there file a statement of claim in case such statement has not been already filed under the provisions of section 1 hereof, such as mentioned in section 6 hereof, and present their proofs touching any priority of right claimed by them for any ditch, canal, or reservoir in said district, which notice shall be published in same manner and times and in all respects according to the provisions for publication of the newspaper notices mentioned in section 6 of this act, and proof of such publication shall be made in the same manner as is provided in section 7 of this act; and he shall also post ten or more printed copies of such notice in ten or more public places in said district, which copies shall be so posted at least twenty days before the time of commencing to take said evidence. (Sec. 11, p. 150, Acts 1881.)

Proof of the posting of said copies shall be made by the affidavit of said referee or other person certified by him to be a credible witness, which shall show when, where, and how the said copies were posted, and shall be filed by him with his report. (Sec. 12, p. 151, Acts 1881.)

1775. Who May Offer Evidence—Former Evidence.]

Said referee shall attend at the times and places mentioned in his said notice, for the purpose therein mentioned; and all persons, associations, choosing to do so, and being interested as owners of or consumers of water from any ditch, canal, or reservoir in said district, and may also attend by themselves, their agents or attorneys, before said referee, at some one or more of said times and places so appointed, and shall have right to offer any and all evidence they may think advisable for their interests in the matter to be adjudicated, as well in districts in which evidence has been heretofore taken as in other districts. All such evidence as has been heretofore taken, if any, in such district, shall be kept present by said referee, subject to inspection by any party desiring to examine the same for purposes of the investigation. (Sec. 13, p. 151, Acts 1881.)

1776. Powers and Duties of Referee—Books and Records—Evidence.]

Said referee shall have power to administer oaths to all witnesses, and to issue subpœnas for witnesses and subpœnas *duces tecum*, which subpœnas may be served by any party, or constable, or sheriff, or deputy sheriff, and may require witnesses to appear at any of the places appointed by said referee for taking evidence. He shall permit all witnesses to be examined by the parties calling them respectively and to be cross examined by any party interested, and he shall take all testimony in writing and note all objections offered to any part of the testimony taken, with the cause assigned for the objection, and shall proceed in all other respects as in case of taking depositions. He shall certify all books and papers offered by any one in his own behalf, and preserve them with the testimony offered concerning the same, and in case of books and papers offered in evidence, which shall not be under the control of the party desiring the evidence for which such books may be offered, said referee shall make a true copy of the parts demanded and certify the same, and preserve the same, together with the evidence offered concerning the same and concerning said books and papers, as part of the evidence in the matter. (Sec. 14, pp. 151–2, Acts 1881.)

1777. Refusal to Produce Books or Papers—Effect.]

No person, association or corporation willfully refusing to produce any book or paper, if in his or their power to do so, when rightfully demanded for examination and copying, shall be allowed the benefit of any testimony or proofs in his, her, or their behalf, in making final adjudication, if the court shall be satisfied, from all the evidence shown concerning such refusal, that the same was willful. (Sec. 15, p. 152, Acts 1881.)

1778. What Facts to be Ascertained by Proofs.]

Said referee shall also examine all witnesses to his own satisfaction, touching any point involved in the matter in question, and shall ascertain as far as possible the

date of the commencement of each ditch, canal, or reservoir, with the original size and carrying capacity thereof, the time of the commencement of each enlargement thereof, with the increased carrying capacity thereby occasioned, the length of time spent in such construction or enlargement, the diligence with which the work was prosecuted, the nature of the work as to difficulty of construction, and all such other facts as may tend to show compliance with the law in acquiring the priority of right claimed for such ditch, canal, or reservoir; and upon all the facts so obtained shall be determined the relative priorities among the several ditches, canals, and reservoirs, the volume or amount of water lawfully appropriated by each, as well as by means of the construction, as by the enlargements thereof, and the time when each such several appropriations took effect. (Sec. 16, p. 152, Acts 1881.)

1779. Disturbing Proceedings—Penalty.]

Every person present before said referee at any time when he shall be engaged in hearing testimony, who shall willfully disturb the proceedings; and every person who shall willfully refuse or neglect to obey any subpœna issued by said referee, when his lawful fees shall be tendered him for his attendance before the referee, shall be guilty of contempt of the court appointing such referee, and on complaint, under oath of the referee or other person, before the said district court, or judge thereof in vacation, may be brought before the court or judge and dealt with accordingly. (Sec. 17, pp. 152–3, Acts 1881.)

1780. Fees of Witnesses—By Whom Paid.]

Every witness who shall attend before said referee under subpœna, by request of any party, shall be entitled to the same fees and mileage as witnesses before the district court in the county in which he shall so attend, and shall be paid by the party requiring his testimony. (Sec. 18, p. 153, Acts 1881.)

1781. Duties of Referee—Rights of Parties—Adjournment—Notice.]

The said referee shall take all the testimony offered, and for that purpose shall give reasonable opportunity to all parties to be heard, and may at any place, when the time limited thereat shall expire, adjourn the further taking of testimony then proposed or desired to be offered to the next place in order according to his said published appointments, and at the last place may continue until all testimony shall be taken or make further appointments at any former place or places as may seem best and most convenient for all parties, giving reasonable notice thereof. (Sec. 19, p. 153, Acts 1881.)

1782. Referee Shall Examine all Testimony—Numbering—Findings—Decree.]

Said referee, upon closing the testimony, shall proceed to carefully examine the same, together with all testimony and proofs which may have been heretofore taken by any former referee in the same district, if any such shall have been taken under the provisions of said act, the title of which is recited in section 4 of this act; he shall make an abstract of all the testimony and proofs in his possession concerning each ditch, canal, and reservoir separately, and shall number each ditch and canal in order, and likewise each reservoir, each class consecutively, and also number the several appropriations of water shown by the evidence, all in manner and form as provided in section 9 hereof, and shall make a separate finding of all the facts connected with each ditch, canal, and reservoir, touching which evidence shall have been offered; and he shall prepare a draught of a decree in accordance with his said findings, in substance the same as the decree mentioned in section four of this act, and conformable also to the provisions of section 9 hereof, so far as the same are applicable, which decree, so prepared by him, shall be returned with his report to the court, and he shall file his report with said evidence, abstract, and findings, and said decree, with the clerk of the court, and inform the judge of so doing without delay. (Sec. 20, pp. 153–4, Acts 1881.)

1783. Filing Report—Court Proceed to Determine—Exceptions—Approval—Entry.]

Upon the filing of said report the court, or judge thereof in vacation, shall cause an order to be entered setting some day in a regular or special term of said court as soon as practicable, when the court will proceed to hear and determine the report, at which time any party interested may appear, himself or counsel, and move exceptions to any matter in the findings or decree made by said referee, and after hearing the same the court shall, if the decree reported be approved, cause the same to be entered of record, or otherwise such modifications thereof, or other decree as shall be found just and conformable to the evidence and the true intent of this act, and to so much of any and all former laws of the State as shall be adjudged consistent herewith. (Sec. 21, p. 154, Acts 1881.)

1784. Failure to Offer Evidence—Water Commissioner Disregard Claims until, etc.—Party obtain Decree and present Certificate.]

No claim of priority of any person, association or corporation, on account of any ditch, canal, or reservoir, as to which he, or she, or they, shall have failed or refused to offer evidence under any adjudication herein provided for, or heretofore provided by this act, the title of which is recited in section 4 hereof, shall be regarded by any water commissioner in distributing water in times of scarcity thereof, until such time as such party shall have by application to the court, having jurisdiction, obtained leave and made proof of the priority of right to which such ditch, canal, or reservoir shall be justly entitled, which leave shall be granted in all cases upon terms as to notice to other parties interested, and on payment of all costs, and upon affidavits or petition sworn to, showing the rights claimed, and the ditches, canals, and reservoirs, with the names of the owners thereof against which such priority is claimed, nor until a decree adjudging such priority to such ditch, canal, or reservoir has been entered, and certificate, such as mentioned in section 4 hereof, shall have been issued to claimant and presented to the water commissioner. (Sec. 22, pp. 154-5, Acts 1881.)

1785. Rights of Parties against Referee for Neglect, Oppression, etc.]

Every party interested shall have the right to complain to the court of any act of willful neglect or oppression on the part of the said referee in exercising his powers under this act, whereby such party shall have been aggrieved, either by refusal of said referee to hear or take evidence offered, or by preventing reasonable opportunity to offer such evidence; and the court may order such proceedings in the premises as will give redress of the grievance, at the cost of said referee, if he appear willfully in fault; otherwise, in case of accident or mistake, costs shall be awarded as to the court shall seem just. (Sec. 23, p. 155, Acts 1881.)

1786. Power of Court to make just Rules—Law construed liberally.]

The district court, or judge thereof in vacation, shall have power to make all orders and rules consistent with this act which may be found necessary and expedient, from time to time during the progress of the case, for carrying out the intent of this act, and of all parts consistent therewith of the said act, the title of which is recited in section 4 hereof; as well as touching the proceedings in court as of the acts and doings of said referee, for the purpose of securing to any party aggrieved by the acts of said referee or any proceeding of the court, opportunity for redress; and this act shall be construed liberally in all courts, in favor of securing to all persons interested the just determination and protection of their rights. (Sec. 24, p. 155, Acts 1881.)

1787. Party must File Claim before offering Evidence.]

No persons, associations, or corporation representing any ditch, canal, or reservoir, shall be permitted to give or offer any evidence before said referee until he, she, or they shall have filed a statement of claim in substance the same in all respects as is required to be filed under the provisions of section 1 hereof. (Sec. 25, p. 155, Acts 1881.)

1788. Re-Argument—Review—Limitation two years.]

The district court, or judge thereof in vacation, shall have power to order, for good cause shown, and upon terms just to all parties, and in such a manner as may seem meet, a re-argument or review, with or without additional evidence, of any decree made under the provisions of this act, whenever said court or judge shall find from the cause shown for that purpose by any party or parties feeling aggrieved, that the ends of justice will be thereby promoted; but no such review or re-argument shall be ordered unless applied for by petition or otherwise within two years from the time of entering the decree complained of. (Sec. 26, p. 156, Acts 1881.)

1789. Who May Appeal—Statement—Approval—Contents—Order—Bond—Conditions.]

Any parties or parties representing any ditch, canal, or reservoir, or any number of parties representing two or more ditches, canals, or reservoirs, which are affected in common with each other by any portion of such decree, by which he or she or they may feel aggrieved, may have an appeal from said district court to the supreme court, and in such case the party or parties joining, desiring an appeal, shall be the appellants, and the parties representing any one or more ditches, canals, or reservoirs affecting in common adversely to the interests of appellants shall be the appellees. The party or parties joining in such appeal shall file a statement in writing, verified by affidavit properly entitled in such cause in the district court, which statement shall show that the appellants claim a valuable interest in the ditch, canal, or reservoir, or two or more of such, which are affected in common with each other by some portion of said decree; also stating the name or names, or otherwise the description of the same, and the name or names, or otherwise the description of any one or more other ditches, canals [or] reservoirs, which by said decree derive undue advantage in respect of priority as against that or those represented by appellants; and also setting forth the

name or names of the party or parties claiming such other one or more ditches, canals or reservoirs, affected in common by said decree adversely to the interest of appellant or appellants, and praying that an appeal be allowed against such other parties as appellees. If the court or judge in vacation, on examination, find such statement in accordance with the statements of claim filed by the parties named as appellees, mentioned in section 1 of this act, he shall approve the same and make an order to be prepared and presented by the appellants allowing the appeal and showing the name or names of the appellants and appellees, with the name or names or description of the one or more ditches, canals or reservoirs claimed by the party or parties appellant and appellee, as shown by their several statements of claim filed as aforesaid, before the taking of testimony, and fix the amount of the appeal bond, which bond shall be executed by one or more of appellants, as principal or principals, and by sufficient securities, and approved by the court or judge in vacation, and shall be conditioned for the payment of all costs which may be awarded against the appellants or any of them in the supreme court. (Sec. 27, pp. 156-157, Acts 1881.)

1790. Copy of Order served on Appellees—Publication posting copies—Proof.]

The order last aforesaid shall be entered of record, and the appellant or appellants shall cause a certified copy thereof to be served on each of the appellees, by delivering the same to him or her, if he or she may be found, or otherwise serving the same in manner the same as may be at the time provided for serving summons from the district court by the laws then in force, and shall also cause the said order to be published in the same manner as the notices required to be published by the referee mentioned in section 11 of this act, and proof of the publication in any newspaper shall be the same as in case of said referee's notice, and proof of the posting of the ten printed copies in the district shall be by affidavit of the parties posting the same, with the certificate of the clerk of the district court appealed from, that the affiant is a known and credible person. (Sec. 28, p. 157, Acts 1881.)

1791. Transcript to be Filed in Six Months—Bill of Exceptions.]

The appellant or appellants shall file the transcript of record of the district court with the clerk of the supreme court at any time within six months after the appeal shall be allowed as aforesaid. Only so much of the decree appealed from, and so much of the evidence as shall affect the appropriations of water claimed by means of the construction or enlargement or re-enlargement of the several ditches, canals and reservoirs mentioned in the order allowing the appeal, need be copied into the bill of exceptions. (Sec. 29, pp. 157-158, Acts 1881.)

1792. Costs in Supreme Court.]

The supreme court, on dismissal of such appeal, or on affirming or reversing the parts of the decree appealed from, in whole or in part, shall award costs, as in its discretion shall be found and held to be equitable. (Sec. 30, p. 158, acts 1881.)

1793. Supreme Court amend or make new Decree, or remand with Instructions.]

The supreme court, in all cases in which judgment is rendered, and any part of the decree appealed from is reversed, and in which it may be practicable, shall make such decree in the matters involved in the appeal as should have been made by the district court, or direct in what manner the decree of that court should be amended. (Sec. 31, p. 158, Acts 1881.)

1794. Filing Proof of Service and Notice—Sixty Days—Supreme Court make Rules.]

The said proof of the service and publication of said order allowing the appeal shall be filed with the clerk of the supreme court within sixty days after the making of said order, and if not so filed the supreme court shall, on motion of the appellee or any of the appellees, at any time after such default in filing said proof, and before the said proof shall be filed, dismiss such appeal, and if the transcript of record be not filed within the time limited by section 29 of this act, such appeal shall, on motion, be dismissed. After the filing of the record and proof of service aforesaid the cause on appeal shall be proceeded with as the rules of the supreme court, or such special rules as said court may make in such cases, and their order from time to time thereunder may require. Said court shall have power to make any and all such rules concerning such appeals as may be necessary and expedient in furtherance of this act, as well as to preparation of the case for submission as to supplying deficiencies of record, if any, and for avoiding unnecessary costs and delay. (Sec. 32, p. 158, Acts 1881.)

1795. Court may Dismiss Referee—Vacancy—new Appointment.]

The district court, or judge thereof in vacation, in case of the death, resignation, illness, absence, or other disability of the referee hereby provided for, or for any misconduct in him, or other good cause to such judge appearing, shall appoint such other properly qualified person in his stead as he shall deem proper, who shall proceed without delay to perform all the duties of his office, as herein pointed out, which shall remain unperformed by his predecessor in office. (Sec. 33, p. 159, Acts 1881).

1796. Suits must be Brought in Four Years—Injunctions in what Cases—what Districts—Commissioner's Duty.]

Nothing in this act or in any decree rendered under the provisions thereof, shall prevent any person, association or corporation from bringing and maintaining any suit or action whatsoever hitherto allowed in any court having jurisdiction to determine any claim of priority of right to water, by appropriation thereof, for irrigation or other purposes, at any time within four years after the rendering of a final decree under this act in the water district in which such rights may be claimed, save that no writ of injuction shall issue in any case restraining the use of water for irrigation in any water district wherein such final decree shall have been rendered, which shall effect [affect] the distribution or use of water in any manner adversely to the rights determined and established by and under such decree, but injunctions may issue to restrain the use of any water in such district not affected by such decree, and restrain violations of any right thereby established, and the water commissioner of every district where such decree shall have been rendered shall continue to distribute water according to the rights of priority determined by such decree, notwithstanding any suits concerning water rights in such district, until in any suit between parties the priorities between them may be otherwise determined, and such water commissioner have official notice by order of the court or judge determining such priorities, which notice shall be in such form and so given as the said judge shall order. (Sec. 34, p. 159, Acts 1881).

1797. After Four Years Suit Barred.]

After the lapse of four years from the time of rendering a final decree in any water district, all parties whose interests are thereby affected shall be deemed and held to have acquiesced in the same, except in case of suits before then brought, and thereafter all persons shall be forever barred from setting up any claim to priority of rights to water for irrigation in such water district adverse or contrary to the effect of such decree. (Sec. 35, p. 160, Acts 1881).

1798. Compensation of Referee—how Paid—His Duty to keep Account.]

The referee appointed [as provided] in this act shall be paid the sum of $6 per day while engaged in discharging his duties as herein provided, and also his reasonable and necessary expenses and mileage at the rate of 10 cents for each mile actually and necessarily traveled by him in going and coming in the discharge of his duties as such referee, which said per diem allowance, expenses, and mileage shall be paid out of the treasury of the county in which such water district shall lie, if it be contained in one county, and if such water district shall extend into two or more counties, then in equal parts thereof, shall be paid out of the treasury of such county into which such district shall extend. He shall keep a just and true account of his services, expenses, and mileage, and present the same from time to time to the district court, or judge in vacation, verifying the same by oath, and the judge, if he find the same correct and just, shall certify his approval thereof thereon, and the same shall thereupon be allowed by the board of county commissioners of the county in which said water district shall lie, but if said [water district] extend into two or more counties, he shall receive from the clerk of the district court separate certificates under seal of the court, showing the amount due him from each county, upon which certificate the board of county commissioners of the respective counties shall allow the same on presentation thereof. (Sec. 36, p. 160, Acts 1881.)

1799. Repeal.]

All laws and parts of laws heretofore in existence inconsistent with the provisions of this act, shall be and the same are hereby repealed. (Sec. 37, p. 160, Acts 1881.)

1800. Sheriff not to Serve Writ outside his County.]

Nothing herein contained shall be construed to authorize any sheriff to serve any writ outside the limits of his own county, or give effect to any record by way of notice or otherwise, in any county other than that in which it belongs. (Sec. 35, p. 106, Acts 1879.)

1801. Fees of District Clerk—How Audited—Paid.]

The fees of the clerk of the district court for a service rendered under this act shall be paid by the counties interested in the same manner as the fees of the water commissioners, upon the said clerk rendering his account, certified by the district judge to the board or boards of county commissioners of said county or counties embracing the water district in case of which the services shall have been rendered. (Sec. 43, p. 108, Acts 1879.)

Session Laws, 1885. Evidence.]

Whenever testimony shall or may be taken in any district created by this act for the purpose of procuring a decree as to appropriation of water and priorities thereof, under the statutes of this State, any testimony therefore taken before any former referee may be introduced, and shall be received as evidence. (Sec. 28, p. 259.)

309. Right of Way—Of water—Crossing—Priority.]

Any ditch company formed under the provisions of this (corporations) act shall have the right of way over the line named in the certificate. (Sec. 275 (85), p. 171, G. L.)

1712. Right of Way of Owners near Streams.]

When any person owning claims in such locality (on the bank, margin, or neighborhood of any stream) has not sufficient length of area exposed to said stream to obtain a sufficient fall of water to irrigate his land, or that his farm or land used by him for agricultural purposes is too far removed from said stream, and that he has no water facilities on those lands, he shall be entitled to a right of way through the farms or tracts of lands which lie between him and said stream, or the farms or tracts of lands which lie above or below him on said stream, for the purposes hereinbefore stated. (Sec. 2, p. 67, acts 1861. Sec. 2, p. 362, R. S. Sec. 1373 (2), p. 515, G. S.)

1713. Extent of such Right of Way.]

Such right of way shall extend only to a ditch, dike, or cutting sufficient for the purpose required. (Sec. 3, p. 67, acts 1861. Sec. 3, p. 363, R. S. Sec. 1734 (3), p. 515, G. L.)

1715. Condemnation of Right of Way.]

Upon the refusal of the owners of tracts of land or lands through which said ditch is proposed to run to allow of its passage through their property the person or persons desiring to open such ditch may proceed to condemn and take the right of way therefor (under the provisions of the "Eminent Domain Act"). (Sec. 1376 (5), p. 516, G. L.)

1716. Only one Ditch if Practicable.]

No tract or parcel of improved or occupied land in this State shall, without the written consent of the owner thereof, be subjected to the burden of two or more irrigating ditches constructed for the purpose of conveying water through said property to lands adjoining or beyond the same when the same object can feasibly and practicably be attained by uniting and conveying all the water necessary to be conveyed through such property in one ditch. (Sec. 1, p. 164, acts 1881.)

1717. Shortest Route must be taken.]

Whenever any person or persons find it necessary to convey water for the purpose of irrigation through the improved or occupied lands of another, he or they shall select for the line of such ditch through such property the shortest and most direct route practicable upon which said ditch can be constructed with uniform or nearly uniform grade and discharge the water at a point where it can be conveyed to and used upon the land or lands of the person or persons constructing such ditch. (Sec. 2, p. 164, acts 1881.)

1718. Owner must Permit Others to Enlarge.]

No person or persons having constructed a private ditch for the purposes and in the manner hereinafter provided shall prohibit or prevent any other person or persons from enlarging or using any ditch by him or them constructed in common with him or them upon payment to him or them of a reasonable proportion of the costs of construction of said ditch. (Sec. 3, p. 164, acts 1881, eminent domain.)

1727. Right of Way to Owners of Wheels, etc.]

The right of way shall not be refused by the owner of any tract of land upon which it is required (by those who wish to place wheels upon the bank of a stream), subject of course to the like regulations as required for ditches, and laid down in sections hereinbefore enumerated. (Sec. 8, pp. 68–9, acts 1861. Sec. 6, p. 364, R. S. Sec. 1377 (6), p. 516, G. L.)

338. Ditch, etc., Company may Condemn Real Estate Needed.]

If any corporation formed under this (corporations) act for the purpose of constructing a * * * ditch * * * shall be unable to agree with the owner for the purchase of any real estate required for the purposes of any such corporation or company, or the transaction of the business of the same, or for right of way, or any other lawful purpose connected with or necessary to the operations of such company, such corporations may acquire such title in the manner provided by law. (Sec. 304 (114), p. 182, G. L.)

339. Entry on Land to Survey, etc.]

Any company formed under the provisions of this act for the purpose of constructing a * * * ditch * * * may cause such examination and survey as may be necessary to the selection of the most advantageous route, and for such purpose, by its officers, agents, or servants, may enter upon the lands of any person or corporation,

but subject to liability for all actual damages which shall be occasioned thereby. (Sec. 305 (115), p. 183, G. L.)

1724. Reservoirs—Right to Water—Right of Way—Embankments.]

Persons desirous to construct and maintain reservoirs for the purpose of storing water shall have the right to take from any of the natural streams of the State and store away any unappropriated water not needed for immediate use for domestic or irrigating purposes; to construct and maintain ditches for carrying such water to and from such reservoir, and to condemn lands for such reservoirs and ditches in the same manner provided by law for the condemnation of lands for right of way for ditches: *Provided*, no reservoir with embankments or a dam exceeding ten feet in height shall be made without first submitting the plans thereof to the county commissioners of the county in which it is situated and obtaining their approval of such plans. (Sec. 38, pp. 106–7, acts 1879.)

1725. Conducting Water in Natural Streams.]

The owners of any reservoir may conduct the water therefrom into and along any of the natural streams of the State, but not so as to raise the waters thereof above ordinary high-water mark, and may take the same out again at any point desired without regard to the prior rights of others to water from said stream; but due allowance shall be made for evaporation and seapage, the amount to be determined by the commissioners of irrigation of the district; or, if there are no such commissioners, then by the county commissioners of the county in which the water shall be taken out for use. (Sec. 39, p. 107, acts 1879.)

1726. Damages.]

The owners of the reservoirs shall be liable for all damages arising from leakage or overflow of the waters therefrom, or by floods caused by breaking of the embankments of such reservoirs. (Sec. 40, p. 107, acts 1879.)

312. Keeping Ditch in Repair.]

Every ditch company organized under the provisions of this (corporations) act shall be required to keep their ditch in good condition, so that the water shall not be allowed to escape from the same to the injury of any mining claim, road, ditch, or other property; and whenever it is necessary to convey any ditch over, across, or above any lode or mining claim, or to keep the water so conveyed therefrom, the company shall, if necessary to keep the water of said ditch out or from any claim, flume the ditch so far as necessary to protect such claim or property from the water of said ditch. (Sec. 278 (88), pp. 172–3, G. L.)

1726. Liability for Damages.]

The owners of reservoirs shall be liable for all damages arising from leakage or overflow of the waters therefrom, or by floods caused by the breaking of the embankments of such reservoirs. (Sec. 40, p. 107, acts 1879.)

1728. Maintaining Embankments—Tail Ditch.]

The owner or owners of any ditch for irrigation or other purposes shall carefully maintain the embankments thereof, so that the waters of such ditch may not flood or damage the premises of others, and shall make a tail ditch so as to return the water in such ditch with as little waste as possible into the stream from which it was taken. (Sec. 7, p. 36, R. S., with first clause, amendment 1872, p. 144, sec. 1, second clause, sup. by sec. 2, p. 78, acts 1876.)

1730. Crossing Highways—Bridge.]

Any ditch company constructing a ditch, or any individual having ditches for irrigation, or for other purposes, wherever the same be taken across any public highway or public traveled road, shall put a good substantial bridge, not less than 14 feet in breadth, over such water-course where it crosses said road. (Sec. 10, p. 364, R. S. Sec. 1381 (10), p. 516, G. L.)

1731. Ditch must be Bridged in Three Days—Duty of Supervisor.]

When any such ditch or water-course shall be constructed across any public traveled road, and not bridged within three days thereafter, it shall be the duty of the supervisor of the road district to put a bridge over said ditch or water-course, of the dimensions specified in section 10 of this chapter, and call on the owner or owners of the ditch to pay the expenses of constructing such bridge. (Sec. 11, p. 364, R. S. Sec. 1382 (21), p. 517, G. L.)

1732. Proceedings against Owner for Payment—Damages.]

If the owner or owners of such ditch refuse to pay the bill of expenses so presented, the supervisor may go before any justice of the peace in the township or precinct and make oath to the correctness of the bill, and that the owner or owners of the ditch refuse payment; and thereupon such justice of the peace shall issue a summons against such owner or owners, requiring him or them to appear and answer to the

complaint of such supervisor in an action of debt for the amount sworn to be due, such summons to be made returnable and served, and proceedings to be had thereon as in other cases; and in case judgment shall be given against such owner or owners the justice shall assess, in addition to the amount sworn to be due as aforesaid, the sum of $10 as damages arising from the delay of such owner or owners, such judgment to be collected as in other cases, and to be a fund in the hands of the supervisor of roads for the repairs of roads in such precinct or district. (Sec. 12, p. 365, R. S. Sec. 1383 (12), p. 517, G. L.)

2988. Allowing Water to Waste on Roads.]

No person or persons, or corporation * * * shall cause waste water, or the water from any ditch, road, drain, or flume or other place, to flow in or upon any road or highway so as to damage the same, and any such person or persons or corporation so offending or violating any of the provisions of this section or any of the sections of this act, for which there is no specific penalty provided, shall pay a fine of not less than $10 nor more than $300 for each offense, and a like fine of $10 for each day that such obstruction shall be suffered to remain in said highway, and shall also be liable to any person or persons or corporation in a civil action for any damages resulting therefrom; and it shall be the duty of the road overseer in the district in which such violation shall occur to prosecute any person, persons, corporation, or corporations violating the provisions of this act. (As amended, p. 326, Session Laws, 1885.)

2990. Bridging Ditch at Road-Crossing.]

Any person or persons, corporation or company, owning or constructing any ditch, race, drain, or flume, in, upon, or across any highway, shall keep the highway open for safe and convenient travel by constructing bridges over such ditch, race, drain, or flume; and within five days after any ditch is constructed across, in or upon any highway at any point thereof so as to interfere with or obstruct such highway, the person or persons owning or constructing such ditch shall erect a good and substantial bridge of not less than 20 feet in width across the same, which shall thereafter be maintained by the county: *Provided*, That all such bridges which shall be of greater length than 20 feet, shall be constructed as herein provided, and thereafter maintained in proper condition for safe travel by the owner or owners of said ditch. Any person or persons, corporation or company, constructing any ditch, race, drain, or flume, in, upon, or across any highway, and failing to keep the highway open for safe and convenient travel, as in this act provided, shall forfeit the sum of $25 to the county for each and every day of failure to keep the same open for safe and convenient travel as aforesaid. And any person or persons, corporation or company, who shall fail to erect a good and substantial bridge across any ditch, race, drain, or flume, within five days after the same is constructed in, upon, or across any highway, and keep the same in proper condition and repair, as herein provided, shall forfeit the sum of $25 to the county for each and every day of failure to erect such bridge and keep the same in repair, as aforesaid, together with the cost of constructing there a good and substantial bridge, or making necessary repairs, which the road overseers of the district shall at once proceed to build or repair, and such party or parties so neglecting shall also be liable in damages to any person or persons damaged by such neglect. (As amended, Session Laws, 1885, p. 324.)

1733. Owner of Ditch must Prevent Waste.]

The owner of any irrigating or mill ditch shall carefully maintain and keep the embankments thereof in good repair, and prevent the water from wasting. (Sec. 1, p. 78, Acts 1876. Sec. 1385 (1), p. 518, G. L.)

1734. Running Excess of Water Forbidden.]

During the summer season it shall not be lawful for any person or persons to run through his or their irrigating ditch any greater quantity of water than is absolutely necessary for irrigating his or their said land, and for domestic and stock purposes; it being the intent and meaning of this section to prevent the wasting and useless discharge and running away of water. (Sec. 2. p. 78, Acts 1876. Sec. 1386 (2), p. 518, G. L.)

1735. Penalty for Violation of this Act.]

Any person who shall willfully violate any of the provisions of this act, shall, on conviction thereof before any court having competent jurisdiction, be fined in a sum of not less than $100. Suits for penalties under this act shall be brought in the name of the people of the State of Colorado. (Sec. 3, p. 78, Acts 1876. Sec. 1387 (3), p. 518, G. L.)

1736. Owner Keep Head-gate—Size of Timbers.]

That the owner or owners of every irrigating ditch, flume or canal, in this State shall be required to erect and keep in good repair a head-gate at the head of their ditch, flume, or canal. Such head-gate, together with the necessary embankments, shall be of sufficient height and strength to control the water at all ordinary stages.

The frame-work of such head-gate shall be constructed of timber not less than 4 inches square, and the bottom, sides, and gate or gates, shall be of plank not less than 2 inches in thickness. (Sec. 1, p. 165, Acts 1881.)

1737. Liability of Owner for Neglect, Refusal.]

Owners of all ditches shall be liable for all damages resulting from their neglect or refusal to comply with the provisions of section 1 (G. S. 1736) of this act. (Sec. 2, p. 165, Acts 1881.)

Ditch owners are also required to construct and maintain a weir or measuring device at the heads of their ditches. (Ch. XIV.)

1755. Interfering with Head-gate, etc.]

Every person who shall willfully open, close, change, or interfere with any head-gate or water box, without authority, shall be guilty of a misdemeanor, and on conviction thereof shall be fined not less than $50, nor more than $300, and may be imprisoned not exceeding sixty days. (Sec. 44, p. 108, Acts 1879.)

1759. Destroying Head-gate, Bank, etc.]

Any person or persons who shall knowingly and willfully cut, dig, break down, or open any gate, bank, embankment, or side of any ditch, canal, flume, feeder, or reservoir in which such person or persons may be a joint owner, or the property of another, or in the lawful possession of another or others, and used for the purpose of irrigation, manufacturing, mining, or domestic purposes with intent maliciously to injure any person, association, or corporation, or for his or her own gain, unlawfully, with intent of stealing, taking, or causing to run or pour out of such ditch, canal, reservoir, feeder, or flume, any water for his or her own profit, benefit, or advantage, to the injury of any other person, persons, association, or corporation, lawfully in the use of such water or of such ditch, canal, reservoir, feeder, or flume, he, she or they so offending shall be deemed guilty of a misdemeanor, and on conviction thereof shall be fined in any sum not less than $5 nor more than $300, and may be imprisoned in the county jail not exceeding ninety days. (Sec. 1, p. 163, Acts 1881.)

1760. Jurisdiction of Justices of the Peace.]

Justices of the peace shall have jurisdiction of all offenses under the provisions of this act (G. S. 1759), saving to any party defendant the right to be tried by a jury, as in other criminal cases before such justices now provided for by law; and also the right to appeal, in manner and form as by law now, or hereafter to be provided for by law, in criminal cases before such justices. (Sec. 2, p. 163, Acts 1881.)

Session Laws 1885. Trespass.]

Every person who shall willfully commit any trespass by entering upon the improved or inclosed land of another, without the permission of the owner thereof, with intent to cut, injure, or destroy any dam, dyke, or embankment kept or maintained for the purpose of storing water in any lake, creek, or reservoir, shall, upon conviction therefor, be punished by imprisonment in the county jail not less than ten days nor more than one year, or by a fine not less than $50 and not more than $1,000, or by both such fine and imprisonment. (P. 165.)

903. Malicious Mischief.]

If any person shall unlawfully, wantonly, willfully, or maliciously cut down, break down, level, demolish, or otherwise destroy or damage any bridge, embankment, mill-dam, or ditch, being the property of another * * * where the value of the personal property destroyed or injured shall exceed $20, shall, on conviction, be punished by imprisonment in the State penitentiary not more than five years, or by a fine not exceeding $1,000; or where the value of the personal property destroyed or injured shall be $20 or under, shall, on conviction, be punished by a fine not exceeding $100, or imprisonment in the county jail not more than three months, or both such fine and imprisonment in the discretion of the court. (As amended Session Laws 1885, p. 167.)

315.]

Any person who shall willfully or maliciously damage or interfere with any * * * ditch, flume, * * * or any of the fixtures, tools, implements, appurtenances, or any property of any company which may be organized under the provisions of this act, upon conviction thereof before any court of competent jurisdiction in the county where the offense shall have been committed, shall be deemed guilty of a misdemeanor, and shall be punished by fine or imprisonment, or both at the discretion of the court, said imprisonment not to exceed one year, and said fine not to exceed $500, which fine shall be paid into the county treasury for the use of the common schools, and said offender shall also pay all damages that any such corporation may sustain, together with costs of suit. (Sec. 297 (107), p. 180, G. L.)

882. Polluting Stream or Ditch.]

If any person or persons shall hereafter throw or discharge into any stream of running water, or into any ditch or flume in this State, any obnoxious substance, such as refuse matter from slaughter-house or privy, or slops from eating-houses or saloons, or any other fleshy or vegetable matter which is subject to decay in the water, such person or persons shall, upon conviction thereof, be punished by a fine not less than $100 nor more than $500 for each and every offense so committed. (Sec. 1, Acts 1874, p. 99. Sec. 165, p. 307, G. L. In force Feb. 13, 1874.)

3259. Damage to Ditches, etc., by Persons Floating Timber.]

That it shall be lawful for any person or persons to float any and all kinds of timber, such as saw logs, ties, fencing poles or posts, and firewood down any of the streams of this State: *Provided*, That any person or persons desiring to float any such timber down said streams shall first execute a bond running to the people of each county through which such timber is floated, in a sum sufficient to cover all damages that may be done to any bridges, dams, or irrigating ditches that are now or may hereafter be constructed in or across any streams of this State, such bond to be approved by the board of county commissioners of the county or counties through which such timber is to be floated. (Sec. 1856 (1), p. 643, G. L.)

3472. How Measured.]

Water sold by the inch by any individual or corporation shall be measured as follows, to wit: Every inch shall be considered equal to an inch square orifice under a 5-inch pressure, and a 5-inch pressure shall be from the top of the orifice of the box put into the banks of the ditch to the surface of the water; said boxes, or any slot or aperture through which such water shall be measured, shall in all cases be 6 inches perpendicular, inside measurement, except boxes delivering less than 12 inches, which may be square, with or without slides; all slides for the same shall move horizontally, and not otherwise; and said box put into the banks of ditch shall have a descending grade from the water in ditch of not less than one-eighth of an inch to the foot. (Sec. 2779 (3), pp. 926–7, G. L. Sec. 6, p. 638, R. S. Amd. Sec. 1, pp. 308–9, Acts 1874 and 1877.)

3478. Illegal Measurement.]

All persons for the purpose of weighing or measuring goods, wares, merchandise, water, or other articles actually sold by him, not in accordance with this chapter, shall be deemed guilty of a misdemeanor, and upon conviction thereof may be imprisoned not exceeding one year, or fined not exceeding $1,000, at the discretion of the court in which the conviction shall be obtained. (Sec. 2785 (9), p. 928, G. L. Sec. 9, p. 309, Acts 1874.)

Colorado Constitution, Art. XVI, Sec. 8. County Commissioners fix Rates for Water.]

The general assembly shall provide by law that the boards of county commissioners in their respective counties shall have power, when application is made to them by either party interested, to establish reasonable maximum rates to be charged for the use of water, whether furnished by individuals or corporations.

311. When Corporation must furnish Water.]

Any company constructing a ditch under the provisions of this act shall furnish water to the class of persons using the water in the way named in the certificate, in the way the water is designated to be used, whether miners, mill men, farmers, or for domestic use, whenever they shall have water in their ditch unsold, and shall at all times give the preference to the use of water in said ditch to the class named in the certificate; the rates at which water shall be furnished to be fixed by the county commissioners as soon as such ditch shall be completed and prepared to furnish water. (Sec. 277 (87), p. 172, G. L.)

1738. Regulating Charges—Proceedings before County Commissioners.]

The county commissioners of each county shall, at their regular January session in each year, hear and consider any and all applications which may be made to them by any party or parties interested in procuring water for irrigation by purchase from any ditch or reservoir furnishing and selling water, or proposing to furnish water for sale, the whole or upper part of which shall lie in such county, which application shall be supported by such affidavit or affidavits as the applicant may see proper to present, showing reasonable cause for such board to proceed to fix the price of water to be thereafter sold from such ditch or reservoir, and [if] such board of commissioners shall, upon examination of such affidavit or affidavits, or from the oaths of witnesses in addition thereto, find that the facts sworn to show the application to be in good faith, and that there is reasonable grounds to believe that unjust prices are, or are likely to be, charged for water from such ditch or reservoir, they shall enter an order fixing a day, not sooner than forty days thereafter nor later than the third day of the [next] regular session of their board, when they will hear all parties directly or indirectly interested in said ditch or reservoir, or in procuring water

therefrom for irrigation, who may appear, as well as all the testimony by witnesses or depositions taken on notices as hereinafter provided, touching the said ditch or reservoir, and the cost of furnishing water therefrom, at which time all persons or corporations interested in said ditch or reservoir, as well as all interested in obtaining water therefrom, or in lands which may be irrigated therefrom, may appear by themselves, their agents, or attorneys, and said commissioners shall then proceed to take action in the matter of fixing such price of water; provided the applicant shall, within ten days from the time of entering such order, cause a copy thereof, duly certified, to be delivered to the owner of such ditch or reservoir, if it be owned by one person, or each of the owners if it be owned by several persons, or to the president, secretary, or treasurer of the company if it belongs to a corporation or association having such officers, or if such owner can not be found he shall cause such copy to be left at his usual place of residence, with some person or member of his family residing there, and over fourteen years of age, and if such ditch officer cannot be found, he shall cause such copy to be left at the office or place of business of the company of which he is such officer, or at his residence if such company have no place of business, and if such ditch is owned by several owners, not an incorporated company, it shall be sufficient to serve such notice by delivering one such copy each to a majority of them, and such applicant shall make affidavit of the manner in which such copy or copies have been served. Depositions mentioned in section 1 hereof, to be used before said commissioners, shall be taken before any officer in the State authorized by law to take depositions, upon reasonable notice being given to the opposite party of the time and place of taking such depositions. (Sec. 1, pp. 94-5-6, Acts 1879.)

1739. Powers and Duties of Board—Subpœnas—Compulsion—Adjournments—Examinations—Facts—Order—Proviso as to Contracts.]

Said board shall hear and examine all legal testimony or proofs offered by any of the parties interested, as before mentioned, as well concerning the value of the construction of such ditch and reservoir as the cost and expense of maintaining and operating the same, and all matters which may affect the just price and value of water to be furnished therefrom; and they shall have power to issue subpœnas to witnesses and compel their attendance, which subpœnas shall be served by the sheriff of the proper county when required; and also to compel the production of books and papers required for evidence in as full and ample a manner as the district court now has. They may adjourn the hearing from time to time to further the ends of justice or suit the general convenience of parties. Upon hearing an [and] considering all the matters and facts involved in the case, the board of commissioners shall enter an order naming and describing the ditch or reservoir with sufficient certainty, and fixing a just price upon all water to be thereafter sold, which price shall not be thereafter changed oftener than once in two years: *Provided*, That no price so fixed shall effect [affect] the rights of parties, or their lawful assignees or grantees, who may have contracts with the company, association, or person owning such ditch or reservoir, or their lessees, grantees, or successors, nor the rights of such owners, lessees, or grantees under such contract, nor shall it in any way affect or hinder the making of such contract. (Sec. 2, p. 96, Acts 1879.)

1740. Right to continue Purchasing Water—Tender of Price—Stockholders—Rights.]

Any person or persons, acting jointly or severally, who shall have purchased and used water for irrigation for lands occupied by him, her, or them, from any ditch or reservoir, and shall not have ceased to do so, for the purpose or with the intent to procure water from some other source of supply, shall have a right to continue to purchase water to the same amount for his, her, or their lands, on paying or tendering the price thereof fixed by the county commissioners as above provided; or, if no price shall have been fixed by them, the price at which the owners of such ditch or reservoir may be then selling water, or did sell water during the then last preceding year. This section shall not apply to the case of those who may have taken water as stockholders or shareholders after they shall have sold or forfeited their shares or stock, unless they shall have retained a right to procure such water by contract, agreement, or understanding, and use between themselves and the owners of such ditch, and not then to the injury of other purchasers of water from or shareholders in [the] same ditch. (Sec. 3, pp. 96, 97, Acts 1879.)

1741.]

The lands now irrigated, or which may be hereafter irrigated, from ditches now taking water from the following described rivers or natural streams of the State of Colorado, are hereby declared to constitute irrigation districts. (Sec 5, p. 97, Acts 1879.)*

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*The act of 1879, by which the first ten districts were created, also provides: "Other irrigation districts may be formed from time to time by the governor on petition of parties interested." Several districts were formed under this power and commissioners appointed, and these new districts were incorporated into the new act.

1802.]

For the better regulation of the distribution of water for irrigation among the several ditches, canals, and reservoirs into which such water may be lawfully taken in times of scarcity thereof, the water districts now or to be hereafter established by law shall be constituted into water divisions, as follows. [Boundaries of districts are omitted.]

1752. Water Commissioners—How Appointed—Vacancies—Removal.]

There shall be one water commissioner for each of the above-named districts and for each district hereafter formed, who shall be appointed by the governor, to be selected by him from persons recommended to him by the several boards of county commissioners of the counties into which water districts may extend, and the water commissioner so appointed shall hold his office until his successor is appointed and qualified. The governor shall, by like selection and appointment, fill all vacancies which may be occasioned by death, resignation, or continued absence from the district, removal or otherwise. Said county commissioners may, from time to time, recommend persons to be appointed as above provided, and the governor may at any time remove any water commissioner in his discretion. (Sec. 16, pp. 98, 99, Acts 1879.)

1753. Oath of Office within ten days.]

That within ten days after his appointment, and before entering upon the duties of his office, such water commissioner shall take and subscribe the oath of office prescribed by the constitution of this State. (Sec. 17, p. 99, Acts 1879.)

1754. Duty of Water Commissioners—Open and shut Head-gates.]

It shall be the duty of said water commissioners to divide the water in the natural stream or streams of their district among the several ditches taking water from the same, according to their prior rights of each respectively; in whole or in part to shut and fasten, or cause to be shut and fastened, by order given to any sworn assistant, sheriff, or constable of the county in which the head of such ditch is situated, the head-gate of any ditch or ditches heading in any of the natural streams of the district, which, in a time of a scarcity of water, shall not be entitled to water by reason of the priority of the rights of others below them on the same stream. (Sec. 18, p. 99, Acts 1879.)

1756. Pay of Commissioners—Duty to keep Accounts—How Paid.]

The water commissioners herein provided shall be each entitled to pay at the rate of $5 per day for each day he shall be actually employed in the duties of his office, not to exceed eighty days in any one year, to be paid by the county or counties in which his irrigation district may lie. Each water commissioner shall keep a just and true account of the time spent by him in the duties of his office, and shall present a true copy thereof, verified by oath, to the board of commissioners of the county in which his district may lie, and said board of commissioners shall allow the same; and if said irrigation district shall extend into two or more counties, then such water commissioner shall present his account for his said services, verified as aforesaid, to the board of county commissioners of each county into which such district extends, and each board of county commissioners shall allow an equal part thereof. (P. 254, Acts 1885.)

1757. Commissioner to Appoint Assistant—Oath—Pay.]

Said water commissioner shall have power, in case of emergency, to employ a suitable assistant to aid him in the discharge of his duties. Such assistant shall take the same oath as the water commissioner, and shall obey his instructions, and shall be entitled to $3 per day for every day he is so employed, not to exceed twenty-five days, to be paid upon the certificate of the water commissioner, in the same manner as provided for paying water commissioners. (Sec. 41, p. 107, Acts 1879.)

1758. Commissioner to begin Work when called on.]

Said water commissioners shall not begin their work until they shall be called on by two or more owners or managers, or persons controlling ditches in their several districts, by application in writing, stating that there is necessity for their action; and they shall not continue performing services after the necessity therefor shall cease.

1722. Pro rata Division among Owners.]

If at any time any ditch or reservoir from which water is or shall be drawn for irrigation shall not be entitled to a full supply of water from the natural stream which supplies the same, the water actually received into and carried by such ditch, or held in such reservoir, shall be divided among all the consumers of water from such ditch or reservoir, as well as the owners, shareholders or stockholders thereof, as the parties purchasing water therefrom; and parties taking water partly under

and by virtue of holding shares, and partly by purchasing the same, to each his share pro rata, according to the amount he, she or they (in cases in which several consume water jointly) shall be then entitled, so that all owners and purchasers shall suffer from the deficiency arising from the cause aforesaid each in proportion to the amount of water which he, she or they should have received in case no such deficiency of water had occurred. (Sec. 4, p. 97, Acts 1879.)

1807. Governor shall Appoint—May Remove—Office—Salary.]

The governor shall appoint a state hydraulic engineer, who shall hold his office for the term of two years, or until his successor may be appointed and qualified. The governor may at any time, upon good cause shown, remove said state engineer. Said state engineer shall have general supervision over the water companies [commissioners] of the different water districts in the State. He shall have his office at the State capitol, in an office to be provided for him by the secretary of state, and be subject to his direction and control; who shall also furnish him with suitable furniture, postage, and such proper and necessary books and instruments as will best enable him to discharge the duties of his office. He shall be paid a salary of $2,000 per annum, payable quarterly, by the state treasurer, on warrants drawn by the state auditor. No person shall be appointed as such hydraulic engineer who is not known to have such theoretical knowledge and practical skill and experience as shall fit him for the position. (Sec. 6, pp, 119–20, Acts 1881.)

1808.—Engineer shall Measure Streams—Collect Facts—Report on Reservoirs—Record.]

Said state engineer shall make, or cause to be made, careful measurements and calculations of the maximum and minimum flow in cubic feet per second of water in each stream from which water shall be drawn for irrigation, as may be best for affording information for irrigating purpose, commencing with those streams most used for irrigation; also, to collect facts and make report as to a system of reservoirs for the storage of water, their location, capacity and cost; and he shall keep proper and full records of his work, observations and calculations. (Sec., 7 p. 120, Acts 1881.)

1809—Oath—Bond—Condition.]

Said state engineer shall, before entering on the discharge of his duties, take and subscribe an oath before some officer authorized by law to administer oaths, to faithfully perform the duties of his office, and file with the secretary of state said oath and his official bond, in the penal sum of $2,000, with sureties to be approved by the secretary of state, and conditioned for the faithful discharge of the duties of his office, and for delivering to his successor or other officer authorized to receive the same, all moneys, implements, books and other property belonging to the State then in his hands or under his control, or with which he may be legally chargeable as such officer. (Sec. 8, pp. 120–1, Acts 1881.)

1810. May appoint Assistants—Pay—Certificate—Warrant.]

Said state engineer will have power to employ assistants at an expense not to exceed $1,500 in any one year, who shall be paid out of any moneys appropriated for that purpose, on certificate of said state engineer, showing the services rendered and the amount therefor [thereof], and on presentation of such certificate to the state auditor by the person entitled thereto, he shall issue his warrant on the state treasurer for the amount thereof, to be paid out of any appropriation as aforesaid, and not otherwise. (Sec. 9, p. 277, Acts 1883.)

1811. Annual Report—When to be made.]

Said state engineer shall prepare and render to the government [governor] yearly, and oftener if required, full and true reports of his work, touching all the matters and duties devolving upon him by virtue of his office, which report shall be delivered at the time when the reports of other State officers are required by law to be made, in order that they may be laid before the general assembly at each regular session thereof. (Sec. 10, p. 121, Acts 1881.

1812. Shall measure Ditches' Feeders—Reservoirs.]

Said state engineer shall, on request of any party interested, on payment of his per diem, charges, and reasonable expenses, measure and ascertain the carrying capacity of any ditch, canal, or feeder, or any reservoir, hereafter constructed or enlarged, and give to the party or parties requiring his services an official certificate of the size and carrying capacity of such ditch, canal, or feeder, in cubic feet per second, as he shall find it to be at the time of measuring the same. (Sec. 11, p. 121, Acts 1881.)

1813. Owners of Ditches shall construct Weirs—State Engineer shall compute Water per second.]

For the more accurate and convenient measurement of any water appropriated pursuant to any judgment or decree rendered by any court establishing the claims of priority of any ditch, canal, or reservoir, the owners thereof shall construct and maintain, under the supervision of the state engineer, a measuring weir or other device

for measuring the flow, in cubic feet per second, the water at the head of such ditch, canal, or reservoir, or as near thereto as practicable. The state engineer shall compute and arrange in tabular form the amount of water that will pass such weir or measuring device in cubic feet per second, at the different stages thereof, and he shall furnish a copy of a statement thereof to any water commissioners having control of such ditch, canal, or reservoir. (Sec. 12, pp. 121-2, Acts 1881.)

308. What Certificate must Contain.]

Whenever any three or more persons associate under the provisions of this act to form a company for the purpose of constructing a ditch for the purpose of conveying water to any mines, mills or lands, to be used for mining, milling, or irrigating of lands, they shall, in their certificate, in addition to the matters required in section 2 of this (corporation) act, specify as follows: The stream or streams from which the water is to be taken out; the point or place on said stream at or near which the water is to be taken out; the line of said ditch, as near as may be; and the use to which the said water is to be applied. (Sec. 274 (84), p. 171, G. L.)

309. Right of Way and Water.]

Any ditch company formed under the provisions of this act shall have the right of way over the line named in the certificate, and shall also have the right to run the water of the stream or streams named in the certificate through their ditch; *Provided*, That the line proposed shall not interfere with any other ditch whose rights are prior to those acquired under this act and by virtue of said certificate, except the right to cross by flume; nor shall the water of any stream be diverted from its original channel to the detriment of any person or persons who may have priority of right. (Sec. 275 (85), p. 171, G. L.)

310. Assessment of Stock.]

Any corporation owning any ditch or canal for conveying, or reservoirs for storing water for irrigation purposes, and the capital stock being fully subscribed and paid up, and when such corporation shall have no income sufficient to keep its ditch, canal or reservoir in good repair, such corporation shall have power to levy an assessment upon the capital stock thereof, to be levied pro rata on all the shares of stock, payable in money or labor, or both, for the purpose of keeping the property of such corporation in good repair, and for the payment of any claim against said corporation not otherwise provided for. But no such assessment shall be made unless the question of making such assessment shall first be submitted to the stockholders of such corporation at an annual meeting, or at a special meeting called for that purpose, and a majority of the stockholders, either in person or by proxy, voting thereon, shall vote in favor of making such assessments; and an action may be maintained to recover any assessment against any delinquent shareholder as provided in section 2 of this act. (Sec. 276 (86), p. 172 G. L.)

313. Consolidation.]

Companies organized under the laws of this State, holding ditches or canals by virtue of their organization, which derive their supply of water for their respective ditches or canals from the same head-gate or gates, or the same source or sources of supply, may consolidate their interests and unite their respective companies under one name and management, by filing a certificate of that fact in the office of the secretary of this State, and a counterpart thereof in the office of the recorder of the county or counties in which such ditches or canals are situated, which certificates shall be signed by the presidents of the companies so uniting, with the common seals of the companies affixed thereto, and shall set forth the fact of such union of interests, and give the name of the new company thus formed. (Sec. 1, Acts 1876, p. 68—omitted in G. L.)

1761. When Free from Taxation.]

All ditches used for the purpose of irrigation, and that only when the water is not sold for the purpose of deriving a revenue therefrom, be, and the same are hereby, declared free from all taxation, whether for State, county, or municipal purposes. (Sec. 1, p. 143, Acts 1872. Sec. 1384 (1), p. 517, G. L.)

3472. Measurement of Water.]

Water sold by the inch by any individual or corporation shall be measured as follows, to wit: Every inch shall be considered equal to an inch square orifice under a 5-inch pressure, and a 5-inch pressure shall be from the top of the orifice of the box put into the banks of the ditch to the surface of the water; said boxes or any slot or aperture through which such water shall be measured shall in all cases be 6 inches perpendicular, inside measurement, except boxes delivering less than 12 inches, which may be square, with or without slides; all slides for the same shall move horizontally, and not otherwise; and said box put into the banks of ditch shall have a descending grade from the water in ditch of not less than one-eighth of an inch to the foot.

3312. May Construct Reservoirs, Ditches, etc.]

The city council and board of trustees in towns shall have the following powers:

Seventy-second. They shall have power to construct public wells, cisterns, and reservoirs in the streets and other public and private places within the city or town, or beyond the limits thereof, for the purpose of supplying the same with water; to provide proper pumps and connecting pipes or ditches; to regulate the distribution of water for irrigating and other purposes, and to levy an equitable and just tax upon all consumers of water for the purpose of defraying the expense of such improvements.

Seventy-third. They shall have the right and privilege of taking water in sufficient quantity for the purpose hereinbefore mentioned, from any stream, creek, gulch, or spring in the State: *Provided*, That if the taking of such water in such quantity shall materially interfere with or impair the vested right of any person or persons or corporation heretofore acquired, residing upon such creek, gulch, or stream, or doing any milling or manufacturing business thereon, they shall first obtain the consent of such person or persons or corporations, or acquire the right of domain by condemnation, as prescribed by the constitution and laws upon that subject, and make full compensation or satisfaction for all the damages thereby occasioned to such person or persons or corporation.

Seventy-fourth. When it shall be deemed necessary by any municipal corporation to enter upon or take private property for any of the above uses, the same shall be examined, appraised, and the damages thereon assessed, and the proceedings in connection therewith shall be in all respects the same as is now or may hereafter be provided by general law for the taking of private property for public or private use. (Sec. 2655 (14), pp, 879-892, G. L.)

4317. May Lease or Purchase Canal.]

Any incorporated town or city in this State shall have power to purchase or lease any canal or ditch already constructed, or which may hereafter be constructed, and all the rights, privileges, franchises of any person or persons, or corporations owning the same or having any interest or right therein, and to hold or operate the same in the same manner as the persons or corporation from whom the same may be purchased or leased might otherwise do: *Provided*, That such purchase or lease shall be made for the purpose of supplying, by said ditch or canal, water for the use of said city or town: *And provided further*, That a majority of the qualified electors of such city or town, who shall vote at any regular election which may be held for the election of town officers, shall vote in favor of said purchase. (Sec. 1, p. 198, Acts 1879.)

3418. Obligations—Repair—Management.]

Any town or city making such purchase or lease shall thereby assume all obligations and other duties which by law devolve upon the owner or owners of such ditch or canal, of whom the same may be purchased or leased by virtue of this act, and shall have power to repair, improve, or enlarge the same, or any flume, dam, or gate connected therewith, and for such objects may levy and collect taxes in the same manner as other taxes are levied and collected by law. The management of such ditch or canal shall be under the control of the board of trustees or councils, as the case may be, of such city or town. (Sec. 2, pp. 198,19, Acts 1879.)

A municipal corporation will, of course, have the same general rights, and be subject to the same general liabilities and duties as any other owner of a ditch or reservoir.

2724. Sale of Arid Lands Conditioned on the Construction of Ditches, etc.]

For the purpose of encouraging cultivation and the making of irrigation ditches, the State board of land commissioners are hereby authorized to sell at public sale, at not less than the appraised value, not more than one-half of any tract of arid land belonging to the State, except the school land, in alternate quarter sections as nearly as may be, to any responsible person or corporation, on condition that said person or corporation dig an irrigation ditch in such location, and of sufficient capacity to furnish water for the entire tract. All contracts for the sale of State lands under the provisions of this section shall be drawn by the attorney-general, and signed by the governor and the secretary of the board, in behalf of the State, and by the other parties in interest; and in no case shall the titles to any of said lands pass from the State until such ditch is completed in a manner satisfactory to the State board, and the purchasers have given, in addition to such price as may be fixed by the State board, a suitable contract or agreement, secured by a sufficient bond, that they will furnish water for the remaining portion of the tract of land, as aforesaid, at not to succeed [exceed] such rates as the State board may agree. Upon the fulfillment of the above conditions patent may issue for not more than one-half of said tract, and the remaining portion of said tract may be subsequently disposed of in the same manner as other State lands. (Sec. 8, p. 226, Acts 1881.)

2744. Sale of Lands Conditioned on the Construction of Ditches, etc.]

The State board of land commissioners may sell in parcels of not more than 5,000 acres, at public sale, at not less than its appraised value, any of the lands granted to the State for public improvements, under the act approved September 4, 1841, conditioned upon the location of colonies thereon, or the construction of extensive lines of ditches covering such lands: *Provided*, That not more than one-half of any one section of land shall be sold, in alternate half sections: *And provided further*, That every alternate one-half section unsold shall not be sold for three years thereafter. (Sec. 2196 (22), p. 728, G, L.)

Sec. 1. Purification of Water—Commission.]

By and with the consent of the senate, the governor shall appoint a commission, consisting of two persons, as follows: One person engaged in farming in this State where irrigation is practiced, and one person engaged in mining in the State. Such commission shall make practical and scientific tests and experiments in attempting to settle and purify the water after being used by stamp mills and smelters, and shall report the results of such tests and experiments to the next general assembly of this State: *Provided*, That all scientific and chemical tests shall be made by the employés of the State school of mines, without any expense to the State: *Provided further*, That the commissioners shall receive no compensation, other than their actual expenses, which shall in no event exceed the sum appropriated by this act.

SEC. 2. The sum of $600, or so much thereof as may be necessary, is hereby appropriated to defray the expenses incurred in carrying out the provisions of this act. (Session Laws, 1885, p. 260.)

316. Flume—What Certificate shall Specify.]

When any company shall organize under the provisions of this act to form a company for the purpose of constructing a flume, their certificate, in addition to the matters required in the second section of this act (G. S. 238), shall specify as follows: The place of beginning, the terminus, and the route as near as may be, and the purpose for which such flume is intended, and when organized, according to the provisions of this act, said company shall have the right of way over the line proposed in such certificate for such flume, provided it does not conflict with the rights of any former fluming, ditching, or other company. (Sec. 279 (89), p. 173, G. L.)

COLORADO STATUTES, 1888.

AN ACT to regulate the mode of fixing the rates of compensation by boards of county commissioners for water furnished and delivered for irrigation and other lawful purposes from ditches, canals, conduits, and reservoirs, and to repeal laws inconsistent therewith, and punish offenses contrary thereto.

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. The county commissioners of each county shall, at their regular sessions in each year, and at such other sessions as they, in their discretion, may deem proper, in view of the irrigation and harvesting season and the convenience of all parties interested, hear and consider all applications which may be made to them by any party or parties interested either in furnishing and delivering for compensation in any manner, or in procuring for such compensation water for irrigation, mining, milling, manufacturing, or domestic purposes from any ditch, canal, conduit, or reservoir, the whole or any part of which shall lie in such county; which application shall be supported by such affidavits as the applicant or applicants may present, showing reasonable cause for such board of county commissioners to proceed to fix the rate of compensation for water to be thereafter delivered from such ditch, canal, conduit, or reservoir within such county.

SEC. 2. Every such board of commissioners shall, upon examination of such affidavit or affidavits, or from the oaths of witnesses in addition thereto, if they find that the facts sworn to show the application to be in good faith and that there are reasonable grounds to believe that unjust rates of compensation are, or are likely to be charged or demanded, for water from such ditch, canal, conduit, or reservoir, shall enter an order fixing a day not sooner than twenty days thereafter, nor later than the third day of the next regular session of their board, when they will hear all parties interested in such ditch or water works as aforesaid, or in procuring water therefrom for any of the said uses, as well as all documentary or oral evidence or depositions, taken according to law, touching the said ditch or other work as aforesaid, and the cost of furnishing water therefrom.

SEC. 3. At the time so fixed all persons interested as aforesaid on either side of the controversy, or in lands which may be irrigated from such ditch or other work aforesaid, may appear by themselves, their agents, or attorneys, and said commis-

sioners shall then proceed to take action in the matter of fixing such rates of compensation for the delivery of water: *Provided*, The applicant or applicants—if the application be made by a party or parties as aforesaid, desirous of procuring water—shall, within ten days from the time of entering the said order fixing the hearing, cause a copy of such order, duly certified, to be delivered to the owner or owners of such ditch, canal, conduit, or reservoir, or to the president, secretary, or treasurer of the company, if it be owned by a corporation or association having such officers. If any such owner can not be found, a copy shall be left at his usual place of abode, with some person residing there, over twelve years of age, and if such officer of any corporation or association can not be found, such copy shall be left at the usual place of business of the company of which he is such officer, or at his residence, if such company have no place of business, and if such ditch or other work aforesaid shall be owned by several owners, not being an incorporated company, it shall be sufficient to serve such notice by delivering one copy each to a majority of them. If the applicant be the owner or party controlling such ditch, canal, conduit, or reservoir, such notice shall be given by causing printed copies of such order, in hand-bill form, in conspicuous type, to be posted securely in ten or more public places throughout the district watered from such ditch or other work aforesaid—if the water be used for irrigation—and one copy shall be posted for every mile in length of such ditch; but if such ditch or other work be for the supply of water for milling or mining, it shall be sufficient to serve such copy on the parties then taking water therefrom. The person or persons making such service or posting such printed copies shall make affidavit of the manner in which the same has been done, which affidavit shall be filed with the said board of county commissioners. Depositions mentioned in section 2 hereof, to be used before said commissioners, shall be taken before any officer in the State authorized by law to take depositions, upon reasonable notice being given to the opposite party of the time and place of taking the same.

SEC. 4. Said board of commissioners may adjourn or postpone any hearing from time to time, as may be found necessary, or for the convenience of parties, or of public business; and they shall hear and examine all legal testimony or proofs offered by any party interested as aforesaid, as well concerning the original cost and present value of works and structure of such ditch, canal, conduit, or reservoir, as the cost and expense of maintaining and operating the same, and all matters which may affect the establishing of a reasonable maximum rate of compensation for water to be furnished and delivered therefrom; and they may issue subpœnas for witnesses, which subpœnas shall be served by the sheriff of the county, who shall receive the lawful fees for all such service; and said board may also issue a subpœna for the production of all books and papers required for evidence before them. Upon hearing and considering all the evidence and facts and matters involved in the case said board of commissioners shall enter an order describing the ditch, canal, conduit, reservoir, or other work in question with sufficient certainty, and fixing a just and reasonable rate of compensation for water to be thereafter delivered from such ditch or other work as last aforesaid within the county in which such commissioners act; and such rate shall not be changed within two years from the time when they shall be so fixed, unless upon good cause shown. The district court of the proper county, or the judge thereof in vacation, may, in case of refusal to obey the subpœna of the board of county commissioners, compel obedience thereto, or punish for refusal to obey, after hearing, as in cases of attachment for contempt of such district court.

SEC. 5. Every person who shall swear or affirm falsely in any matter or testify falsely after being duly sworn or having affirmed as a witness in any proceeding provided for in this act shall be deemed guilty of perjury, and on conviction shall be punished accordingly.

SEC. 6. All acts and parts of acts inconsistent with this act are hereby repealed; but such repeal shall not work any interference with any proceeding by any board of county commissioners now pending, saving that any such proceeding may, at the request of either party, be carried on to completion under the provisions hereof.

SEC. 7. In consequence of the near approach of the irrigating season it is deemed that an emergency exists, and therefore this act shall take effect from and after the time of its approval.

Approved and in force April 4, 1887.

AN ACT to define, prohibit, punish, and restrain extortion and other abuses in the management of ditches, canals, and reservoirs.

Be it enacted by the General Assembly of the State of Colorado:

SEC. 1. It shall not be lawful for any person owning or controlling, or claiming to own orcontrol, any ditch, canal, or reservoir carrying or storing, or designed for the carrying or storing, of any water taken from any natural stream or lake within this State to be furnished or delivered for compensation for irrigation, mining, milling, or domestic purposes to persons not interested in such ownership or control, to demand,

bargain for, accept, or receive from any person, who may apply for water for any of the aforesaid purposes, any money or other valuable thing whatever, or any promise or agreement therefor, directly or indirectly, as royalty, bonus, or premium, prerequisite or condition precedent to the right or privilege of applying or bargaining for or procuring such water; but such water shall be furnished, carried, and delivered upon the payment or tender of the charges fixed by the county commissioners of the proper county, as is or may be provided by law. Any and all moneys, and every valuable thing or consideration of whatsoever kind which shall be so as aforesaid demanded, charged, bargained for, accepted, received, or retained contrary to the provisions of this section shall be deemed and held an additional and corrupt rate, charge, or consideration for the water intended to be furnished and delivered therefor, or because thereof, and wholly extortionate and illegal, and when paid or delivered, or surrendered may be recovered back by the party or parties paying, delivering, or surrendering the same from the party to whom or for whose use the same shall have been paid, delivered, or surrendered, together with all costs of suit, including reasonable fees of attorneys of plaintiff, by proper action in any court having jurisdiction.

SEC. 2. Every person owning or controlling, or claiming to own or control, any ditch, canal, or reservoir, as is mentioned in the first section of this act, who shall, after demand in writing made upon him for the supply or delivery of water for irrigation, mining, milling, or domestic purposes, to be delivered from the ditch, canal, or reservoir owned, possessed, or controlled by him, and after tender of the lawful rate of compensation therefor in lawful money, demand, require, bargain for, accept, receive, or retain from the party making such application any money or other thing of value, or any promise or contract or any valuable consideration whatever, as such royalty, bonus, premium, prerequisite, or condition precedent, as is by the provisions of the said first section of this act prohibited, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by fine of not less than one hundred dollars nor more than five thousand dollars, or imprisonment for a term not less than three months nor more than one year, or both such fine and imprisonment, in the discretion of the court.

SEC. 3. Every person owning or controlling, or claiming to own or control any ditch, canal, or reservoir such as is mentioned in the first section of this act, who shall, after demand in writing made upon him for the supply or delivery of water for irrigation, mining, milling, or domestic purposes, to be delivered from the ditch, canal, or reservoir owned, possessed, or controlled by him, and after tender of the lawful rate of compensation therefor in lawful money, refuse to furnish or carry and deliver from such ditch, canal, or reservoir, any water so applied for, which water can or may be by use of reasonable diligence in that behalf and within the carrying or storage capacity of such ditch, canal, or reservoir, be lawfully furnished and delivered, without infringement of prior rights, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by fine of not less than one hundred dollars nor more than five thousand dollars, or imprisonment for a term of not less than three months nor more than one year, or both such fine and imprisonment in the discretion of the court.

SEC. 4. When any corporation in defiance or by attempted evasion of the provisions of this act, shall after tender of the compensation hereinbefore provided for, refuse to deliver water such as is mentioned in the third section of this act, to any person lawfully entitled to apply therefor, it shall be the duty of the attorney-general, upon request of the county commissioners of the proper county, or upon his otherwise receiving due notice thereof, to institute and prosecute to judgment and final determination proceedings in *quo warranto* for the forfeiture of the corporate rights, privileges, and franchises of any such corporation so offending, or by *mandamus* or other proper proceedings to compel it to its duty in that behalf.

SEC. 5. The word person as used in this act shall include corporations and associations and the plural as well as the singular number; and every officer of a corporation or member of an association or co-ownership, and every agent violating any of the provisions of this act, shall be liable to restore the unlawful consideration extorted, and be punishable under the penal provisions of this act, the same as if the thing done in disobedience to its provisions were done for his own sole benefit and advantage.

SEC. 6. All laws and parts of laws in conflict with any of the provisions of this act are hereby repealed.

Approved, April 4, 1887. In force, July 3, 1887.

AN ACT to amend section 42 (16), chapter LVII, of the general statutes of the State of Colorado, entitled "Irrigation," requiring the water commissioners to give bond in an amount to be fixed by the board of county commissioners, and providing for the governor to fix the amount of such bond in the event that the county commissioners disagree thereon.

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. That section 42, of chapter 57, of the general statutes of the State of Colorado, entitled "Irrigation," the same being general section 1752 thereof, be, and the same is hereby, amended so as to read as follows:

SEC. 42. There shall be one water commissioner for each of the above named districts, and for each district hereafter formed, who shall be appointed by the governor, to be selected by him from persons recommended to him by the several boards of county commissioners of the counties into which water districts may extend, and the water commissioner so appointed shall, before entering upon his duties, give a good and sufficient bond for the faithful discharge of his duties, with not less than three sureties, in a sum not less than one thousand dollars nor more than five thousand dollars; the amount of said bond to be fixed by the county commissioners and approved by the governor and state engineer. The commissioner so appointed shall hold his office until his successor is appointed and qualified: *Provided, however,* that if such water district shall be embraced in more than one county, and the several counties in which such water district is situated disagree as to the amount of the bond as herein required of water commissioners, then and in that event the governor shall fix the amount thereof, with the same effect as though fixed by the county commissioners.

SEC. 2. The governor shall, by like selection and appointment, fill all vacancies which may be occasioned by death, resignation, or continued absence from the district, removal or otherwise. Said county commissioners may, from time to time, recommend persons to be appointed as above provided; and the governor may at any time remove any water commissioner, in his discretion.

Approved March 15, 1887. In force June 13, 1887.

AN ACT regulating the distribution of water, and the superintendence of canals or ditches used for the purpose of irrigation, and providing a penalty for the violation thereof.

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. Every person or company owning or controlling any canal or ditch used for the purposes of irrigation shall, during the time from April 15th, to November 1st, in each year, keep a flow of water therein, so far as may be reasonably practicable for the purpose of irrigation, sufficient to meet the requirements of all such persons as are properly entitled to the use of water therefrom, to the extent, if necessary, to which such persons may be entitled to water, and no more: *Provided, however,* That whenever the rivers or public streams, or sources from which the water is obtained, are not sufficiently free of ice, or the volume of water therein is too low and inadequate for that purpose, then such canal or ditch shall be kept with as full a flow of water therein as may be practicable; subject, however, to the rights of priorities from the streams or other sources, as provided by law, and the necessity of cleaning, repairing, and maintaining the same in good condition.

SEC. 2. The owners or persons in control of any canal or ditch used for irrigating purposes shall maintain the same in good order and repair, ready to receive water by April 15th in each year, so far as can be accomplished, by the exercise of reasonable care and diligence, and shall construct the necessary outlets in the banks of the canal or ditch for a proper delivery of the water to persons having paid up shares, or who have purchased rights to the use of the water: *Provided, however,* That a multiplicity of outlets in the canal or ditch shall at all times be avoided, so far as the same shall be reasonably practicable, and the location of the same shall be under the control of, and shall be at the most convenient and practicable points consistent with the protection and safety of the ditch for the distribution of water among the various claimants thereof; and such location shall be under the control of a superintendent.

SEC. 3. It shall be the duty of those owning or controlling such canals or ditches to appoint a superintendent, whose duty it shall be to measure the water from such canal or ditch through the outlets, to those entitled thereto according to his or her pro rata share.

SEC. 4. Any superintendent or any person having charge of the said ditch who shall willfully neglect or refuse to deliver water as in this act provided, or any person or persons who shall prevent or interfere with the proper delivery of water to the person or persons having the right thereto, shall be guilty of a misdemeanor, and upon conviction thereof shall be subject to a fine of not less than ten nor more than one hundred dollars for each offense, or imprisonment not exceeding one month, or by both such fine and imprisonment, and the money thus collected shall be paid into the general fund of the county in which the misdemeanor has been committed, and the owner or owners of such ditches shall be liable in damages to the person or persons deprived of the use of the water to which they were entitled, as in this act provided.

SEC. 5. Any water commissioner, or his deputy or assistant, who shall willfully neglect or refuse, after being called upon in accordance with section 1758 of the general statutes of the State, to promptly measure water from the stream or other source of supply into the irrigating canals or ditches in his district, according to their respective priorities, to the extent to which water may be actually necessary for the irrigation of lands under such canals or ditches, shall be deemed guilty of a misdemeanor, and shall be subject to the same penalty as provided in section four of this act.

SEC. 6. In all cases declared misdemeanors by this act, any justice of the peace of the county in which the offense was committed, may, upon complaint being made as is now required by law, issue a warrant directed to any proper officer of the county, for the arrest of any person so charged with any such misdemeanor, and upon the arrest of such person or persons, the justice of the peace before whom such person or persons may be brought for trial shall hear and determine the cause, and if he find the accused guilty, shall assess the fine, and if imprisonment be a portion of the sentence, then to fix the term of imprisonment, or both, as provided in section 4 of this act: *Provided*, The accused may have a trial by jury, which shall be summoned as in cases before justices of the peace for assault and battery.

Approved March 19, 1887. In force June 17, 1887.

AN ACT providing for the appointment of superintendents of irrigation for the water divisions of this State; fixing their compensation and providing for the payment thereof; prescribing their duties, and requiring a bond for the faithful performance of such; requiring clerks of district courts to furnish such superintendents with certain certified decrees, and providing for the payment of such clerks' fees.

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. That the governor shall appoint a superintendent of irrigation for each of the water divisions now existing within the State, or which may hereafter be created. Such superintendents of irrigation to hold office for a period of two years from the date of their respective appointments, or until their successors may be appointed and qualified. The governor may at any time in his discretion remove said superintendents of irrigation, or any of them and appoint others in their stead for the remainder of said term of two years: *Provided*, That the governor shall not appoint a superintendent of irrigation in any district [division] until the board of county commissioners of some one or more of the counties whose territory or any part of whose territory is included in such water district [division] shall have at a meeting regularly called and held, adopted a resolution requesting such appointment to be made, and have had the same certified to the governor.

SEC. 2. Said superintendent of irrigation shall have general control over the water commissioners of the several districts within his division. He shall, under the general supervision of the State engineer, execute the laws relative to the distribution of water in accordance with the rights of priority of appropriation as established by judicial decree, and perform such other functions as may be assigned to him by the State engineer.

SEC. 3. Said superintendent of irrigation shall, in the distribution of water, be governed by the regulations of this act and acts that are now in force, but, for the better discharge of his duties, he shall have the authority to make such other regulations to secure the equal and fair distribution of water, in accordance with the rights of priority of appropriation as may in his judgment be needed in his division: *Provided*, Such regulations shall not be in violation of any part of this act, or other laws of the State, but shall be merely supplementary to and necessary to enforce the provisions of the general laws and amendments thereto.

SEC. 4. Any person, ditch company or ditch owner who may deem himself injured or discriminated against by any such order or regulation of such superintendent of irrigation, shall have the right to appeal from the same to the State engineer, by filing with the State engineer a copy of the order or regulation complained of, and a statement of the manner in which the same injuriously affects the petitioner's interest. The State engineer shall, after due notice, hear whatever testimony may be brought forward by the petitioner, either orally or by way of affidavits, and through the superintendent of irrigation shall have power to suspend, amend or confirm the order complained of.

SEC. 5. Said superintendent of irrigation shall commence the discharge of his duties in his division as soon as the first water commissioner in any district within his division shall be called out, and shall continue to discharge his duties until the last water commissioner in any district of his division ceases to be needed. Each water commissioner shall report immediately to the superintendent of irrigation of his division when he is called out and when he ceases to be needed, and shall, during the continuance of his duties, be under the control of the superintendent of irrigation of his division. The superintendent of irrigation shall receive as compensation five dollars per day for every day during which he is employed in the discharge of his duty.

SEC. 6. Within thirty days after the appointment of said superintendent of irrigation, it shall be his duty to give bond to the amount of ten thousand dollars for the

faithful discharge of his duty, said bond to be approved by the board of county commissioners of the county wherein said superintendent of irrigation may reside, and to be filed in the office of the county clerk and recorder of such county.

SEC. 7. Within thirty days after his appointment, said superintendent of irrigation shall send to the clerk of the district court, within his division, of such counties as have had rendered by the district court of such county, judicial decrees fixing the priorities of appropriation of water for irrigation purposes for any water district, a notification of his appointment to such office, and shall request of the said clerk a certified copy of every decree of the district court establishing priorities of appropriation of water used for irrigation purposes within that district. Thereupon it shall be the duty of the clerk within ten days after the receipt of such request from said superintendent of irrigation, to prepare a certified copy of all decrees of such district court establishing priorities of water rights made within that district, under the provisions of the general statutes of the State of Colorado, and transmit the same to the superintendent of irrigation requesting it. Said superintendent of irrigation shall then cause to be prepared a book to be entitled "The register of priorities of appropriations of water rights for water division No. ——, State of Colorado," within which he shall enter and preserve such certified copies of decree. Said superintendent of irrigation shall then, from such certified copies of decree, make out a list of all the ditches, canals and reservoirs entitled to appropriations of water within his division, arranging and numbering the same in consecutive order according to the dates of their respective appropriations within his division, and without regard to the number such ditches, canals and reservoirs may bear within their respective water districts. Such superintendent of irrigation shall then enter from his register a tabulated statement of all the ditches, canals and reservoirs in his division, whose priorities have been decreed, which statement shall contain the following information concerning each ditch, canal and reservoir arranged in separate columns: The name of the ditch, canal or reservoir, its number in his division, the district in which it is situated, the number of it in its proper district, and the number of cubic feet of water per second to which it is entitled, and such other and further information as he may deem useful to the proper discharge of his duty. In case any decrees of court establishing priorities of appropriation of water for irrigation purposes are made after the transmittal of the copy of previous decrees to the superintendent of irrigation, it shall be the duty of the clerk of the court wherein such decree is rendered, to transmit to the superintendent of irrigation of the division within which such county is situated, within ten days after it is rendered, a copy of such decree, and the superintendent of irrigation shall enter the same in his register. Such register to be filed and kept in the office of the State engineer.

SEC. 8. Said superintendent of irrigation shall have the right to call out any water commissioner of any water district within his division at any time he may deem it necessary, and he shall have the power to perform the regular duties of water commissioner in all the districts within his division.

SEC. 9. All water commissioners shall make reports to the superintendent of irrigation of their division as often as may be deemed necessary by said superintendent. Said reports shall contain the following information: The amount of water necessary to supply all the ditches, canals and reservoirs of that district; the amount of water actually coming into the district to supply such ditches, canals and reservoirs; whether such supply is on the increase or decrease; what ditches, canals and reservoirs are at that time without their proper supply; the probability as to what the supply will be during the period before the next report will be required; and such other and further information as the superintendent of irrigation of that division may suggest. Said superintendent of irrigation shall carefully file and preserve such reports, and shall from them ascertain what ditches, canals and reservoirs are, and what are not, receiving their proper supply of water, and if it shall appear that in any district in that division any ditch, canal or reservoir is receiving water whose priority post dates that of the ditch, canal or reservoir in another district, as ascertained from his register, he shall at once order such post-dated ditch, canal or reservoir shut down and the water given to the elder ditch, canal or reservoir. His orders being directed at all times to the enforcement of priority of appropriation, according to his tabulated statement of priorities, to the whole division, and without regard to the district within which the ditches, canals and reservoirs may be located. The reports of water commissioners, by the superintendents of irrigation, shall be filed and kept in the office of the State engineer.

SEC. 10. In case any ditch, canal or reservoir, in any district within such superintendent of irrigation's division, shall fail to receive its regular supply of water, the owner of such ditch, canal or reservoir may report such fact to the water commissioner of that district, who shall immediately apportion the water in his district, and send forthwith, by telegram if necessary, a report of such fact to the superintendent of irrigation of his division; and thereupon it shall be the duty of the superintendent to compare such report with his register, and if any ditch, canal or reser-

voir of any other district of his division is receiving water to which any ditch, canal or reservoir of any other district is entitled, he shall at once order the shutting down of the post-dated ditches, canals or reservoirs, and the water given to the ditches, canals or reservoirs having the priority of appropriation: *Provided, however*, That nothing in this act shall be construed as interfering with the priority of water for domestic use.

SEC. 11. Such superintendent of irrigation shall, in the discharge of his duties, be clothed with the powers of justice of the peace, and any person violating his orders relative to the opening or shutting down of head-gates, or the using of water for irrigation purposes, shall be deemed guilty of contempt, and summary punishment may be inflicted, not exceeding ninety days' imprisonment, or three hundred dollars fine, or both.

SEC. 12. The expenses and salary of the superintendents of irrigation shall be paid *pro rata* by the counties interested, in the same manner as the fees of water commissioners are paid; and the fees of the clerks of the district courts, for services rendered under the provisions of this act, shall also be paid by the counties interested, upon the said clerk rendering his account, certified by the district judge, to the boards of county commissioners of the counties embraced in the water divisions, in case of which the services have been rendered.

SEC. 13. That it is the opinion of this general assembly that an emergency exists; therefore, this act shall take effect and be enforced from and after its passage.

Approved and in force April 4, 1887.

AN ACT to provide for the better protection of water rights and to declare a liability in damages for the infringement thereof.

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. That it shall be the duty of every person who is entitled to take water for irrigation purposes from any ditch, canal, or reservoir to see that he receives no more water from such ditch, canal, or reservoir through his head gate or by any ways or means whatsoever than he is entitled to, and that he shall at all times take every precaution to prevent more water than he is entitled to coming from such ditch, canal, or reservoir upon his land.

SEC. 2. That it shall be the duty of every such person taking water from any ditch, canal, or reservoir to be used for irrigation purposes, on finding that he is receiving more water from such ditch, canal, or reservoir either through his head gate or by means of leaks or by any means whatsoever immediately to take steps to prevent his further receiving more water from such ditch, canal, or reservoir than he is entitled to, and if knowingly he permits such extra water to come upon his land from such ditch, canal, or reservoir and does not immediately notify the owner or owners of such ditch, or take steps to prevent its further flowing upon his land, he shall be liable in damages to any person, company, or corporation who may be injured by such extra appropriation of water for the actual damage sustained by the party aggrieved, which damages shall be adjudged to be paid together with the costs of suit and a reasonable attorney's fee to be fixed by the court and taxed with the costs.

SEC. 3. That it is the opinion of this general assembly that an emergency exists; therefore, this bill shall be in force and take effect from and after the day of its passage.

Approved and in force April 4, 1887.

AN ACT to compel the owners of canals and ditches situated within cities of the first class, or cities existing by special charter of a population equal to or exceeding said cities of the first class, to confine flume and cover the same at their own expense.

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. That every corporation and company, whether created by special act or organized under the general incorporation laws of this State, and every partnership, person, or persons who now, or may at any time hereafter, own or control any canal or ditch, or any part thereof, being two feet in width or over, and carrying water to the depth of twelve inches or over, which canal or ditch or any part thereof is within the corporate limits of any city denominated in the law as of the first class, or any city existing by special charter of a population equal to or exceeding said cities of the first class, or any of the additions thereto, shall, at their own expense, within sixty days after this act shall take effect, confine flume, and cover all or any part of such canal or ditch, whether located on, or across private property, public highways or alleys in said city or additions thereto in a reasonable and sufficient manner and with such materials as will render such fluming or covering safe and a sure protection to the lives and property of the inhabitants of said city; and any such corporation, company, partnership, person, or persons shall at all times thereafter keep and maintain any and all such structures confining fluming and covering of such canal or ditch in good order and repair at their own expense.

SEC. 2. Such corporation, company, partnership, person, or persons shall, at their own expense, safely and securely lattice or slat the head of such flume or [illegible] with proper materials, so that persons or animals can not accidently enter such [illegible] or covering at the head thereof and pass or be carried down the current of [illegible] nal or ditch, and shall thereafter maintain and keep the same in good [illegible] repair at their own proper cost and expense.

SEC. 3. If any such corporation, company, partnership, person, or persons shall fail or refuse to comply with any of the provisions of the two preceding sections, such corporation, company, partnership, person, or persons shall forfeit and pay to the county, for the use of the common school fund the sum of fifty dollars [illegible] every day such failure or refusal shall continue; to be recovered by a civil action in the name of the people of the State of Colorado, in any court of competent jurisdiction: *Provided*, That nothing in this act shall be construed to bar an action for actual damages by any person who shall have suffered such damages by reason of the failure to comply with any of the provisions of this act.

SEC. 4. Whereas in the opinion of this general assembly an emergency exists, therefore, this act shall be in force from and after its passage.

Approved and in force March 29, 1887.

AN ACT to amend section two of an act of the general assembly of the State of Colorado entitled "An act to provide for the extension of the right of way for ditches, canals, and [illegible] in certain cases, and requiring registration of all such hereafter made or enlarged, approved February 11, 1881, being general section No. 1720 of the general statutes of the State of Colorado," which is section 10 of chapter LVII of said general statutes, entitled "Irrigation."

Be it enacted by the general assembly of the State of Colorado:

SEC. 1. That section two (2) of said act (approved February 11, 1881), being section No. 1720 of the general statutes of the State of Colorado, which is section 10 of chapter 57 of said general statutes, entitled "Irrigation," be, and the same is hereby, amended so as to read as follows:

SEC. 2. Every person, association, or corporation hereafter constructing or enlarging any ditch, canal, or feeder for any ditch or reservoir for irrigation, and taking water directly from any natural stream, and of a carrying capacity of [illegible] cubic foot of water per second of time, as so constructed or enlarged, shall within ninety (90) days after the commencement of such construction or enlargement file in the office of the county clerk and recorder of the county in which the head-gate of such ditch or feeder may be situated, and also in the office of the State hydrographic engineer a map showing the point of location of such head-gate, the route of such ditch or canal, or the high-water line of such reservoir or reservoirs, and the line of such feeder to and ditches or canals from such reservoir or reservoirs; the [illegible] ions of the lands upon which such structures are built or to be built, if on unsurveyed lands; the names of the owners of such lands as far as the same are known at the office of the county clerk of the county in which they are situated; the distances, and corners, by reference to legal subdivisions, if on surveyed lands, and natural objects if on unsurveyed lands, as will clearly designate the location of such structures. Upon or attached to such map shall be a statement showing:

First. The point of location of the head-gate above mentioned.

Second. The depth, width, and grade of such ditch, canal, or feeder.

Third. The carrying capacity of such ditch, canal, or feeder, in cubic feet per second of time, and the capacity of such reservoir or reservoirs in cubic feet, up to the high-water mark.

Fourth. The time of commencement of work on such structures, which shall be dated from the commencement of the surveys therefor. In case of enlargement such statement shall also show the matters required in items second and third above, as to the enlargement, and state the increased [illegible] largement. If such statement [illegible] of way and water [illegible] mencing work; or [illegible] That nothing here[illegible] diligence in the p[illegible] same. Such st[illegible] whose behal[illegible] ment shall b[illegible] same shall [illegible]

Approv[illegible]

WYOMING DIVISION.

CHEYENNE, WYO., *September* 17, 1889.

The committee met pursuant to call of the chairman.

Present: Mr. Stewart (chairman) and Mr. Jones, of Arkansas; also Director Powell.

STATEMENT OF CHARLES BELLAMY, OF LARAMIE.

The CHAIRMAN. What is your occupation?

Mr. BELLAMY. I am a civil engineer and a surveyor.

Mr. CHAIRMAN. How long have you resided in Laramie City?

Mr. BALLAMY. Off and on for ten years.

The CHAIRMAN. Are you familiar with the topography and water supply and the land to be irrigated in any portion of Wyoming; if so, what portions are you familiar with?

Mr. BELLAMY. Yes; I am familiar with the two Laramie rivers and their tributaries.

The CHAIRMAN. Are there two Laramie rivers?

Mr. BELLAMY. The Big and Little Laramie. They join 10 or 12 miles north of Laramie City, and then it is the main Laramie River from there on.

The CHAIRMAN. Of what altitude are the Laramie Plains?

Mr. BELLAMY. The altitude of Laramie City is 7,123 feet, and the plains average, I should say, from 7,000 to 6,000 feet where the Laramie River enters the hills.

The CHAIRMAN. What crops can you produce in the Laramie Plains at that altitude?

Mr. BELLAMY. I am not very familiar with the raising of crops, not being a ranch man.

The CHAIRMAN. You have been surveying there?

Mr. BELLAMY. Yes. I know that oats can be raised, of the very best quality.

The CHAIRMAN. Do they raise wheat there?

Mr. BELLAMY. Yes; very fair wheat has been raised, although not in any great quantity. It has been mostly experimental.

The CHAIRMAN. Do they raise vegetables of any kind?

Mr. BELLAMY. Yes; they raise all the vegetables, such as potatoes, cabbage, onions, etc.

The CHAIRMAN. Do the Laramie Plains require irrigation to produce crops?

Mr. BELLAMY. Certainly.

The CHAIRMAN. What is the chance to irrigate on the plains, and what is the water supply?

Mr. BELLAMY. I could best show that with the map. I have prepared a large map of those two rivers.

The CHAIRMAN. How is the map marked?

Mr. BELLAMY. It is marked "Map of the irrigating ditches of the Laramie Plains." [Describing the map.] The black lines show the rivers and the blue lines the ditches; the blue spots are the lakes or ponds. It is divided into townships and subdivided into sections. The scale is 1 inch to the mile. The map begins at a point 3 miles north of the Colorado line and runs to where the Laramie River enters the Black Hills.

The CHAIRMAN. That river passes through the Black Hills, does it?

Mr. BELLAMY. Yes.

The CHAIRMAN. It enters into the North Platte?

Mr. BELLAMY. Yes; on this side of the Black Hills.

The CHAIRMAN. How far north from here is the Laramie River when it gets through the hills?

Mr. BELLAMY. From 60 to 65 miles. That is, where it passes into the Black Hills it is that much, and where it enters the Platte River it is, I guess, 85 or 90 miles.

The CHAIRMAN. It is the largest fork of the Platte, is it?

Mr. BELLAMY. Yes.

The CHAIRMAN. You raise grass crops there, do you?

Mr. BELLAMY. Yes.

The CHAIRMAN. What kind of grass crops can you raise there with irrigation?

Mr. BELLAMY. I could not tell the names of them; I know there is blue grass, and timothy, and alfalfa, and also red-top. I do not know the names of the other kinds.

The CHAIRMAN. What do you say of the supply of water in the streams for irrigation; how extensive is it?

Mr. BELLAMY. There is a supply on both the forks of the Laramie that could be stored so as to be used when wanted, but it comes down with such a rush that it can not be used at all.

The CHAIRMAN. Are there other streams entering into the Laramie; has it many branches?

Mr. BELLAMY. Yes; quite a number.

The CHAIRMAN. Are they represented on the map?

Mr. BELLAMY. Yes.

The CHAIRMAN. Do they furnish much water in the spring time?

Mr. BELLAMY. Yes; when the spring freshets are on almost all these little creeks furnish water enough for irrigation, but they last only two weeks, sometimes, and that is not long enough for irrigation.

The CHAIRMAN. Are there opportunities for storing the water?

Mr. BELLAMY. Yes; quite a number. In Sand Creek, for example, which heads in Colorado, there is a chance, in two or three different places, on each farm on Sand Creek, by just damming across the cañon to store a considerable quantity of water.

The CHAIRMAN. Has the land in the valley been entered; that is, the even sections? The railroad, I suppose, has the other sections or most of them?

Mr. BELLAMY. Most of them.

The CHAIRMAN. And along the creeks, how is it?

Mr. BELLAMY. It is pretty much taken up on the creeks.

The CHAIRMAN. As to the plain between the streams the even sections are still Government lands, are they?

Mr. BELLAMY. Yes.

Senator JONES. How much land is irrigated of the sixty-six townships that you show on this map?

Mr. BELLAMY. I have not figured that out, but I should think there are about 500,000 acres under ditch.

Senator JONES. I mean what is actually irrigated?

Mr. BELLAMY. That I can not say.

Senator JONES. Is it three-fourths, or one-half, or 10 per cent., or what?

Mr. BELLAMY. Perhaps a little more than 10 per cent.

The CHAIRMAN. That would be about 50,000 acres?

Senator JONES. Actually in irrigation and under cultivation?

Mr. BELLAMY. Yes.

Senator JONES. Are they actually under irrigation and under cultivation?

Mr. BELLAMY. Yes.

Senator JONES. Is there water enough in the country to irrigate the balance of the 500,000 acres?

Mr. BELLAMY. I think there is, if it were stored.

Senator JONES. There is not enough in the season?

Mr. BELLAMY. At present there is enough, but during the freshet there is more water than they can use, though it does not last long.

Senator JONES. That is, in the spring?

Mr. BELLAMY. Yes.

Senator JONES. I am speaking of the water in the ditches. Do the ditches, during the irrigating season, furnish water enough to irrigate the land?

Mr. BELLAMY. Yes. They would, during the high water, if they had a full supply and were running full.

Senator JONES. Do they run full during the entire irrigating season?

Mr. BELLAMY. Not during the entire irrigating season; only about two weeks.

Senator JONES. The difficulty then is, that there is not enough water in the streams to furnish the water required for the ditches?

Mr. BELLAMY. No.

Senator JONES. Would storage be the remedy for that?

Mr. BELLAMY. Yes.

The CHAIRMAN. Have you made any calculation to see how much could be irrigated if it were stored?

Mr. BELLAMY. I will tell you some work I have done. Here is a ditch in township 14 north, range 77 west. It comes out on the south boundary of the township, on the left bank of the Big Laramie River. The ditch at present is constructed, for about 2½ miles, 16 feet wide on the bottom, and 5 or 6 feet deep. The carrying capacity of that ditch is not large enough for the land it could irrigate. From the present terminus of the ditch, if there were water enough in the Big Laramie River to last long enough, that ditch would irrigate almost the entire body of the land between the Big and Little Laramies.

Senator JONES. How long would that ditch have to be, to accomplish that which you suggest?

Mr. BELLAMY. The main ditch would have to be about 45 miles long, with, I should say, 100 miles of laterals.

Senator JONES. That would irrigate how much land?

Mr. BELLAMY. That would irrigate very nearly six townships.

The CHAIRMAN. Is there water enough at present to irrigate any such amount of land?

Mr. BELLAMY. Yes, by storage.

The CHAIRMAN. I mean without storage, is there enough?

Mr. BELLAMY. I think not. It don't last long enough. It comes down with a rush and all is gone; not the whole of it, but there is not enough left in two weeks to supply all. The center of Lake Hattie, in the southwest corner of township 15 north, range 76 west, could be turned into a reservoir from this ditch, and then, from that lake the water could be carried over quite an extent of country.

Senator JONES. That lake would not be big enough to do anything, if it is correctly shown on the map.

Mr. BELLAMY. It could be made a great deal larger from the ground around.

The CHAIRMAN. Is there any place higher up on the Laramie?

Mr. BELLAMY. Yes; in Colorado there are quite a number of places. Above Cumming City, which is about 5 miles north of the Colorado line, the river runs into a cañon, and from there on back it would spread over quite a large extent of country.

The CHAIRMAN. Would it be private land or public land?

Mr. BELLAMY. I can not say just how much of that is filed on and how much is not.

The CHAIRMAN. What other operations might be had in the valley?

Mr. BELLAMY. With regard to the Little Laramie, that is a stream that is causing much trouble with the ranchmen. The people up above wanted to take the water and deprive the people below altogether. At the foot of the Snowy Range there are a number of lakes. Some of them run into the Little Laramie and other places, and I think there is the greatest chance for a large amount of storage of water.

The CHAIRMAM. What other streams are there?

Mr. BELLAMY. There is Rock Creek.

Senator JONES. If all the water coming down the Little Laramie should be stored in the lakes at the head of the river, would there be more than enough water to fill the ditch?

Mr. BELLAMY. Yes.

Senator JONES. How much would it increase in quantity?

Mr. BELLAMY. This ditch, in range 78 west, could be continued in to Lake James. That would irrigate all this land in between the lake and the Little Laramie.

Senator JONES. Would there be water enough for all of it?

Mr. BELLAMY. Yes. Even now, when the the Little Laramie is up in the spring, with all these ditches running full, there is still the bank-full besides, for a little over two weeks.

The CHAIRMAN. How much of a lake is that?

Mr. BELLAMY. It covers fully two sections.

The CHAIRMAN. Can you draw the water from it?

Mr. BELLAMY. No; the banks all around it are too high.

The CHAIRMAN. What stream is there immediately beyond that?

Mr. BELLAMY. There is Seven-Mile Creek and Four-Mile Creek. These two creeks have ditches on them, but they have no particular chance for reservoirs. Four-Mile Creek does not run into Lake James, but into the Laramie River.

The CHAIRMAN. There is another lake below that, is there not?

Mr. BELLAMY. Yes; Cooper Lake.

The CHAIRMAN. Can that be made a storage reservoir?

Mr. BELLAMY. I think it might be, but to supply that lake the water would have to be taken either from the Little Laramie or Rock Creek.

Senator JONES. Is the level of Cooper Lake high enough to irrigate the land on the level of it?

Mr. BELLAMY. It would have to be raised up 20 feet.

The CHAIRMAN. Could you run a cut or tunnel into it?

Mr. BELLAMY. I believe it is a little higher than the river, but I do not know that anybody has ever made a survey of it.

Senator JONES. Has there ever been any survey made of the water running down the Big and Little Laramie Rivers?

Mr. BELLAMY. Yes; Mr. Mead has that.

The CHAIRMAN. Is there anything further that you wish to say?

Mr. BELLAMY. I would like to add that in township 18 north, range 74 west, on this side of the Laramie, and for a distance of about 15 miles, there is a space for reservoir use that will irrigate a whole township. There is fully a half township under irrigation there.

STATEMENT OF ELWOOD MEAD, CIVIL ENGINEER, OF CHEYENNE.

The CHAIRMAN. What is your profession?

Mr. MEAD. Civil engineer.

The CHAIRMAN. Have you any official position?

Mr. MEAD. I am the engineer of this Territory, and have the general supervision of the waters of the Territory and of the officials in the engineer's department.

The CHAIRMAN. Have you given attention to the subject of irrigation, the water supply, and the lands to be irrigated in the Territory of Wyoming?

Mr. MEAD. Yes.

The CHAIRMAN. Have you prepared any statement on the subject of irrigation?

Mr. MEAD. I have one report here dealing with some of the general features of the subject and two supplementary reports giving statistics.

The CHAIRMAN. State generally what your report contains.

Mr. MEAD. A general statement of the character of the irrigation development here and some of the difficulties that we have encountered; also some criticisms of the present methods and recommendations as to suitable measures to improve them. The supplementary statements give the statistics.

The CHAIRMAN. Of what has been done.

Mr. MEAD. Yes.

Senator JONES. Does it give the quantity of land under cultivation by irrigation?

Mr. MEAD. Yes.

Senator JONES. And the quantity under ditch that is not in cultivation?

Mr. MEAD. No; it is impossible to determine between the two. It gives the quantity under ditch.

Senator JONES. It does not give the quantity under actual cultivation?

Mr. MEAD. No; there is no way to arrive at that.

Mr. JONES. In some instances nine-tenths of the land under ditch is not in cultivation and it is important to know when there is any material difference.

Mr. MEAD. Yes; but it would be impossible at the present time to ascertain that.

Senator JONES. Do you approximate it.

Mr. MEAD. No; I can not attempt that. The statistics given of ditch construction are of the ditches actually constructed and which are in a condition to water these lands, as far as we could make it so.

The CHAIRMAN. Are you familiar with the different localities, having passed over the country personally?

Mr. MEAD. Yes; I am. Between two-thirds and three-fourths of the territory, or nearly so, has been visited by me personally.

The CHAIRMAN. Are you familiar with the Laramie Plains?

Mr. MEAD. Yes.

The CHAIRMAN. Have you made a report on those?

Mr. MEAD. Not a specific report on those.

The CHAIRMAN. Are they capable of producing crops with irrigation?

Mr. MEAD. Yes.

The CHAIRMAN. What kind of crops?

Mr. MEAD. All the hardier cereals and hardier vegetables.

The CHAIRMAN. How is it as to grasses?

Mr. MEAD. They will produce excellent grass.

The CHAIRMAN. We have had a map of the Laramie Valley presented here. What proportion of the valley is susceptible of irrigation, that is, that you could get a water supply for? Have you made a calculation on that?

Mr. MEAD. No, I have not made any estimate. I would not undertake to say.

The CHAIRMAN. You have never gauged the streams?

Mr. MEAD. Yes, I have a complete record for this year.

Senator JONES. Is that information in the statistics that you will present to the committee?

Mr. MEAD. Yes.

The CHAIRMAN. Have you examined the valley with a view of ascertaining the opportunities for storage, to increase the supply of water by saving what water does flow?

Mr. MEAD. I have only made a partial examination of that. I went over every part of the streams and there are a number of favorable places for reservoirs—a number that are not shown on the map that Mr. Bellamy showed you. The country is not sufficiently settled for me to locate them with sufficient accuracy to mention them on the map.

The CHAIRMAN. What are the other basins or water sheds?

Mr. MEAD. I have a statement covering this matter in type, that will be presented to you describing these drainage basins. I can go over it now if you desire it.

Senator JONES. I think it will be as well to have the statement filed.

The CHAIRMAN. You need not go over it particularly, but I would like to ask some questions about the different basins.

Mr. MEAD. Very well, I will commence with the first. Here [referring to the map] is an outline of division No. 1, comprising the drainage of the Platte River, which is absolutely independent of any other portion of the Territory.

The CHAIRMAN. The Platte River and its tributaries?

Mr. MEAD. Yes.

The CHAIRMAN. What tributaries are there to the Platte, within its drainage basins?

Mr. MEAD. Several hundred streams that are used for irrigation.

The CHAIRMAN. They are already used, are they, for that purpose?

Mr. MEAD. There are almost two hundred streams in that one basin that are used for irrigation. Many of them are small.

The CHAIRMAN. About what amount of land lies so that it can be covered by the water in that basin?

Mr. MEAD. It would be impossible to state at present how much of

it would be covered, for it would take an examination of almost every one of those streams to determine that matter and it has been impossible to make it.

The CHAIRMAN. Is it large or small, the amount that is susceptible of irrigation?

Mr. MEAD. Quite a large area. In the eastern portion, nearly the whole capacity of the tributaries of the Platte has been utilized.

The CHAIRMAN. Has there been any storage resorted to for its increase?

Mr. MEAD. Not to any considerable extent; only a few small basins.

The CHAIRMAN. You say they have exhausted the water that runs through the basin in the irrigation season, in the eastern portion?

Mr. MEAD. Yes.

The CHAIRMAN. But no effort has been made to save the water?

Mr. MEAD. No.

The CHAIRMAN. Have you any idea of the amount of the water that runs to waste?

Mr. MEAD. There has not been much this season, but generally there is. Quite a considerable portion runs to waste in the early spring, when there has been much snow-fall, but it has been practically all utilized this year. On the main stream of the Platte but very little has been done. The main channel itself has had no considerable irrigation. The principal development has been in the upper portion where it could be done cheaply.

The CHAIRMAN. Give us a description of the Platte River from the time it leaves the mountains, where the Laramie River enters into it, down into Nebraska.

Mr. MEAD. From the time it leaves Colorado, in the upper portion, there are great facilities both for diverting ditches and for constructing storage reservoirs. That is one of the best sections of this country that I have examined for that purpose. There are large numbers of natural basins situated from half a mile to a mile from the stream. One company has been incorporated to irrigate a large quantity of land there. Nothing has been done about the incorporation yet, but it is feasible. After the stream enters the territory, for about 100 miles, the banks become higher.

The CHAIRMAN. What is its character where it leaves the territory and enters Nebraska?

Mr. MEAD. It follows a country where it could be diverted, but at more expense. It becomes broader and has a more extensive bend. I should say about 150 miles of it would be of that character.

The CHAIRMAN. Above that it has a rocky bottom so that you can take it out.

Mr. MEAD. It is not exactly a rocky bottom. It has a rocky bottom in some places and earth bottom in others. Nearly all the streams come back to the surface. Next to the Little Laramie the next important tributary of the Big Laramie is the Sweetwater, with 1,000 cubic feet per second.

The CHAIRMAN. Do you put the Sweetwater in that division?

Mr. MEAD. Yes. The Little Laramie and the Sweetwater are the two important tributaries, although there are a number of other smaller streams that are excellent streams for irrigation.

The CHAIRMAN. What is the next division on your map?

Mr. MEAD. The next includes the streams that are east of the Big Horn Mountains. It is northeast on that map, but there is a very slight curve. All the streams that leave the Big Horn are good streams.

The CHAIRMAN. Where do they discharge their waters?

Mr. MEAD. Into the Missouri and its tributaries.

The CHAIRMAN. They all get into the Yellowstone pretty much, do they not?

Mr. MEAD. Those streams that have their heads north of the Big Horn Mountains have not so much importance for irrigation. There are a number of streams in the northeastern portion of the territory in which it needs as little water for irrigation as any.

The CHAIRMAN. What is the altitude of that section?

Mr. MEAD. From 3,500 feet to 6,000 feet. Sheridan is the lowest point I know of.

The CHAIRMAN. That section is lower than the Laramie plains?

Mr. MEAD. Yes.

The CHAIRMAN. Is there much population in that section?

Mr. MEAD. Yes, Johnson and Sheridan Counties are the principal farming districts of the State at this time.

The CHAIRMAN. Have you visited those counties?

Mr. MEAD. Yes.

The CHAIRMAN. How much land is irrigated in that division.

Mr. MEAD. Let me describe the situation and you will understand the difficulty of making an estimate.

The CHAIRMAN. Describe it.

Mr. MEAD. Each one of the valleys of these streams will vary in width from half a mile to 3 or 4 miles. Then you go over a divide. In some places, owing to the immense fall of the country, they have carried the water over those ridges; they are not too steep to prevent irrigation but you can not get a view of the country. You can not form any estimate of it. You will look at one valley and you can see a certain portion of it, but it is impossible to form any estimate.

The CHAIRMAN. Is there nobody who knows how much, whether it is a large quantity or a small quantity?

Mr. MEAD. I should say that there are 100,000 acres, perhaps, that are being farmed there, but I may be mistaken. That includes the hay that is cut as well as the grain.

The CHAIRMAN. What is the character of the crops grown over in that section?

Mr. MEAD. Everything that is grown in Iowa and Kansas.

The CHAIRMAN. Are the crops good?

Mr. MEAD. Yes, the finest yield of wheat I have ever seen is in Johnson County. I understand that it yielded 90 bushels to the acre last year, and that the yields are uniformly large. The yield of all small grains, however, in this whole territory is large. The finest timothy I ever saw is grown there—6 feet high. It seems to be peculiarly adapted to that crop.

The CHAIRMAN. Is there anybody present who farms over there?

Mr. MEAD. Both Mr. Burt and Mr. Coffeen can give you that information, I think.

The CHAIRMAN. What is the other district?

Mr. MEAD. The third district is the Big Horn and its tributaries.

The CHAIRMAN. Is that all in your statement?

Mr. MEAD. Yes.

Senator JONES. It seems to be better to have it in that shape?

Mr. MEAD. On the Big Horn, this part of the country north of the reservation, I have never examined, but I have had a number of reports from surveyors.

Senator JONES. Are those included in the statements you are going to file?

Mr. MEAD. No; not the reports. I have had no time to include duplicates of them. It is included in correspondence running over a couple of years.

Senator JONES. Is there anybody here who can explain the Big Horn country?

Mr. MEAD. Yes; but I can describe the general features of that country. I am familiar with it, although I have never been over it.

Senator JONES. That is not in your report, is it?

Mr. MEAD. No. A great many of those streams have banks of considerable height, so that it would be expensive to divert the water, but in the southern portion there are large areas that can probably be reclaimed in time, whenever they will justify the expense of constructing the headworks. I think there will be no difficulty in utilizing the flow of the Big Horn basin. There is a large valley 60 miles by 30 miles that could all be watered from one system. One canal would water the whole tract. The third division is the Greene, the Bear, and the Snake Rivers.

Senator JONES. That is in the western portion?

Mr. MEAD. Yes. The waters of the Greene can best be diverted in the upper portion.

Senator JONES. North of the railroad?

Mr. MEAD. North of the railroad; from 50 to 125 miles north.

Senator JONES. What is the character of the country up there?

Mr. MEAD. It is a fine country—as fine as you ever saw.

Senator JONES. The Greene is a good river, is it, up there?

Mr. MEAD. Yes. And there are a large number of storage basins there. You will see the natural lakes that exist on the head-waters of those streams. After you get down below the country becomes rolling and is of no value for irrigating purposes. All those streams on the west side of the Greene have narrow valleys and there is quite a considerable settlement in them, but no large areas can be brought under cultivation on the west side of the Greene. The Bear River flows out of Colorado into Wyoming and crosses over into Idaho, then re-enters the Territory and again leaves it and passes again into Idaho.

Senator JONES. Is there much water on the Bear?

Mr. MEAD. All the water on the Bear River was diverted this year by a Utah corporation.

Senator JONES. Where does the Bear empty its waters?

Mr. MEAD. It finally empties them into Salt Lake. The valley varies in width usually from 2 to 3 miles. In many places it is wider than that and in some places it is narrower. It is easy to divert the water. It was all utilized this year.

Senator JONES. Have you never heard any estimates made as to the amount of land in Wyoming that may ultimately be brought under cultivation?

Mr. MEAD. Yes, all the way from 5,000,000 to 10,000,000 acres.

Senator JONES. The estimates vary that much, do they?

Mr. MEAD. Yes.

Senator JONES. You are not prepared to say which is the nearest correct, the 5,000,000 or the 10,000,000?

Mr. MEAD. I would not want to state unless with modifications. I have stated that in my report.

STATEMENT OF M. C. BROWN, OF LARAMIE CITY.

The CHAIRMAN. Do you know the character of the crops that may be produced in the Laramie Valley?

Mr. BROWN. Yes.

The CHAIRMAN. Please state them.

Mr. BROWN. All of the hardier cereals and vegetables, and with perfect success. They grow abundantly. I think that the best quality of barley that I have ever seen in my life I saw grow near Laramie City, on the plains; also as fine oats as have ever been grown in any country on earth.

The CHAIRMAN. Is that regular? Are the crops reliable?

Mr. BROWN. Every year when there is sufficient water.

The CHAIRMAN. There is no other difficulty than want of water?

Mr. BROWN. No.

The CHAIRMAN. The altitude and frost do not affect them?

Mr. BROWN. I have never known frost to affect grain or the hardier vegetables.

The CHAIRMAN. It is too high to raise corn?

Mr. BROWN. Yes; corn has been grown there, but not with success.

The CHAIRMAN. What is regarded as a good crop of wheat, barley, and oats?

Mr. BROWN. From 30 to 40 bushels an acre of wheat; from 30 to 50 bushels of oats to the acre.

Senator JONES. Is that an average crop year after year?

Mr. BROWN. Yes.

Senator JONES. The average over the entire country and for a number of years?

Mr. BROWN. The extent of farming in that country is limited; the people have never indulged in that business to any great extent, because they have never had water sufficient to irrigate their crops.

Senator JONES. I understand that; what I mean, are your estimates the general average over the country that is irrigated for a series of years?

Mr. BROWN. Yes.

The CHAIRMAN. Do you raise good potatoes there?

Mr. BROWN. Yes; as good as grow anywhere on the earth, and in large quantities.

The CHAIRMAN. You have lived there sometime?

Mr. BROWN. Twenty years.

The CHAIRMAN. Have you observed the flow of water in the streams?

Mr. BROWN. Somewhat. I am not very familiar with the flow of water, but have visited the streams frequently through the year and know something of them.

The CHAIRMAN. Do they have considerable floods?

Mr. BROWN. Yes. In the early spring, say from the middle of April, the water begins to flow in considerable quantities, increasing from week to week until July. I think it reaches its height in the early part of July.

The CHAIRMAN. What is the irrigation season?

Mr. BROWN. From the 1st of June on.

The CHAIRMAN. To how late a period?

Mr. BROWN. Up to about the middle or last of July.

The CHAIRMAN. And you want irrigation during that time?

Mr. BROWN. Yes. In some years they need to irrigate in May.

The CHAIRMAN. Not to exceed sixty days, then?
Mr. BROWN. From sixty to ninety days.
Senator JONES. At what time do you harvest your wheat there?
Mr. BROWN. In August and September, usually.
Senator JONES. You have no trouble with early frost?
Mr. BROWN. We have early frosts, but the grain usually ripens before that; sufficiently so that the frost does not harm it.
Senator JONES. Has there been any effort made to increase the efficiency of your streams by reservoirs?
Mr. BROWN. No, not to any great extent.
Senator JONES. Has there been any resort to artesian wells in the Laramie Plains?
Mr. BROWN. Yes, there are quite a number of artesian wells, but the flow from such wells is not large.
The CHAIRMAN. Not large enough to be of any value for irrigating purposes?
Mr. BROWN. I can not say that it would not be of any value, but it would be of no very considerable value unless the wells were of greater depth than any we have made up to this time.
Senator JONES. Do you know how deep they are, as a rule?
Mr. BROWN. The deepest I know of is about 1,500 feet.
Senator JONES. Do you know anything about the volume of the waters afforded by those wells?
Mr. BROWN. I do not as from measurement. I can say nothing about that except to say that a number of wells produce quite a stream of water.
Senator JONES. Is that water used for irrigating purposes?
Mr. BROWN. I think in a few instances, to a very limited degree. It is used for irrigating trees, plants, and things of that kind more than for any other purpose.
Senator JONES. There is no idea prevailing there that artesian wells can be made a material factor in the question of irrigation?
Mr. BROWN. I think not.
The CHAIRMAN. Do you wish to make any further suggestion?
Mr. BROWN. I want to make this suggestion in answer to some remarks of Senator Jones: If the United States can distribute the water in such a way as to irrigate these lands then homesteads are possible, and I agree with him that those lands should be distributed among the citizens of this country as homes. But they can not have homes without water on those arid lands. In Illinois and Iowa the lands were valuable without irrigation. Let the United States make these lands, by irrigation, what the lands of Iowa are without irrigation, and we will be satisfied with the same amount of land as homes for our people.

STATEMENT OF CHARLES W. BURDICK, OF SARATOGA.

The CHAIRMAN. In what part of the Territory is Carbon County?
Mr. BURDICK. In the southern portion, at the head of the Platte River.
The CHAIRMAN. How far from here?
Mr. BURDICK. One hundred and ninety miles west. I believe that is the distance by railroad. It is a little shorter by the overland line.
The CHAIRMAN. Is there any irrigation practiced in your locality?
Mr. BURDICK. Yes; the small streams are used to the extent of their capacity. The Platte is not used to any great extent.

The CHAIRMAN. Is there any water running to waste in the flood time usually?

Mr. BURDICK. There is water that runs to waste.

The CHAIRMAN. Has any effort been made to retain it?

Mr. BURDICK. No, never.

The CHAIRMAN. Has there been any digging out of the streams in the mountains or hills above to make them flow more water?

Mr. BURDICK. No.

The CHAIRMAN. In the Territory of Utah they have increased their supply immensely by scraping out the stream beds and thereby opening the streams. They have not stored any water. Is there opportunity to do that in the small streams that come into the Platte?

Mr. BURDICK. I do not recollect any places where it could be done. Possibly I am not familiar enough with the method.

Senator JONES. That can only be done where the streams go back to the cañons. They could go to the cañons, remove obstructions there and in the stream beds, so as let the water flow better.

Mr. BURDICK. I do not believe that that would have any material effect. The only thing I think of that would have an effect there would be the cutting down to bed-rock and obtaining the water that flows underneath.

The CHAIRMAN. Is that one of the things that is done?

Mr. BURDICK. I do not know that that is done here, but I think it might be done. It is a fact that in low-water seasons the water sinks and then rises in places; then sinks again for a mile or so, and then again rises to the surface.

The CHAIRMAN. What is the extent of irrigation in your county? How much ground is under irrigation?

Mr. BURDICK. I estimate that in what we call the Platte Valley there are now probably 200,000 acres under ditches. I do not mean by that that it is all irrigated.

The CHAIRMAN. How much of that is irrigated and cultivated?

Mr. BURDICK. Not over 25,000 acres, I think. That includes what you call hay land and river bottom.

The CHAIRMAN. Is there water for the ditches?

Mr. BURDICK. There is water for the ditches, but there would not be water enough in the ditches to cultivate and irrigate the land lying below the ditches.

The CHAIRMAN. Do the ditches come from the small streams or from the Platte?

Mr. BURDICK. From the small streams principally. I think all the land is cultivated now that can be cultivated by the water that runs in the ditches, unless we waste the water.

The CHAIRMAN. It is usually the case that two-thirds of the water is wasted. You do differently from most people if you do not waste it. What kind of crops do you raise there?

Mr. BURDICK. Small grains and vegetables. The elevation is about 7,000 feet. I have never noticed any effect of the frost on our crops.

The CHAIRMAN. Do you raise fair crops of small grains?

Mr. BURDICK. Fair; about 30 bushels to the acre of oats and 25 of wheat.

Senator JONES. How much of potatoes?

Mr. BURDICK. Thirty-five bushels is the average, but we raise them very fine and very large. The soil seems to be particularly adapted to potatoes.

The CHAIRMAN. But your crop is only 35 bushels?

Mr. BURDICK. Only that. I am giving you the exact figures from my own experience. I do not believe in exaggerated figures. I have raised all those grains myself.

STATEMENT OF MARK HOPKINS, OF ROCK SPRINGS.

The CHAIRMAN. In what part of the Territory is Sweetwater County?

Mr HOPKINS. In the southwestern part of the Territory; it is in what is called water district No. 4.

The CHAIRMAN. On what stream do you live?

Mr. HOPKINS. I live on Bitter Creek.

The CHAIRMAN. On what part of Bitter Creek?

Mr. HOPKINS. Within 20 miles of the mouth of the stream.

The CHAIRMAN. Is there any cultivation on Bitter Creek?

Mr. HOPKINS. Very little; in fact, none that I know of.

The CHAIRMAN. There may be a little up in the mountains in the springs, where the creek comes out?

Mr. HOPKINS. No, I do not think there is any land in cultivation on Bitter Creek whatever. The water that would have to be relied on for cultivation in Sweetwater County would be on Greene River and its tributaries.

The CHAIRMAN. Do you know anything of that river and its tributaries?

Mr. HOPKINS. Yes, there is plenty of water in the river and the land seems to be productive.

The CHAIRMAN. Have you examined it?

Mr. HOPKINS. I have seen some small gardens.

The CHAIRMAN. Is there anybody here who is familiar with the Greene River north of the road?

Mr. HOPKINS. The country is uninhabited.

The CHAIRMAN. Entirely uninhabited?

Mr. HOPKINS. Yes.

The CHAIRMAN. Have you been over it?

Mr. HOPKINS. Yes.

The CHAIRMAN. Is it fit for habitation?

Mr. HOPKINS. Yes; there is a very nice valley about 40 miles long located between Sandy Creek and Bitter Creek, about 3 to 5 miles wide and about 40 miles long.

The CHAIRMAN. Can that be irrigated?

Mr. HOPKINS. I am not prepared to say. It would be a matter of survey to determine whether it could be irrigated. The waters of the Sandy, as I understand, could be diverted into that valley, and instead of following the regular course of Greene River Valley they could be flumed across a sandy district there.

Senator JONES. Could the water be carried out of Greene River into that valley?

Mr. HOPKINS. I think it could be done, but only a survey could determine that.

Director POWELL. There would be no trouble about it. Itcan be done. I have personally surveyed that country.

Senator JONES. Is there any farming at all in the locality you live in?

Mr. HOPKINS. There is some farming, though it is not what you would call farming. There is some grass grown by water that they get from the springs, but nothing of any amount. It would be a great boon

to have some farm lands in that district. In other words, there is a home market for productions of that character.

The CHAIRMAN. It is an extensive coal-producing district?

Mr. HOPKINS. Yes.

STATEMENT OF C. W. HOLDEN, OF UINTAH COUNTY.

The CHAIRMAN. Where do you reside?

Mr. HOLDEN. I reside on the Fontenelle, in Uintah County.

The CHAIRMAN. Into what stream does the Fontenelle discharge its waters?

Mr. HOLDEN. It empties into Greene River.

The CHAIRMAN. Is that country inhabited much?

Mr. HOLDEN. Yes.

The CHAIRMAN. Are there farmers there?

Mr. HOLDEN. Yes.

The CHAIRMAN. Is there much irrigation there?

Mr. HOLDEN. Yes.

The CHAIRMAN. What amount of land is under irrigation in Uintah County?

Mr. HOLDEN. I have a statement here prepared under the auspices of the board of county commissioners of that county, bearing directly on that question, furnished me for use before this committee. I think this statement is more to the point and contains less that you do not care to know. I would like to read it.

The CHAIRMAN. You can read it if is not too lengthy.

Mr. HOLDEN. I think it contains all the information I could give myself, and perhaps much more.

The following is the letter:

EVANSTON, WYO., *September* 13, 1889.

DEAR SIR: Your letter of the 10th instant, addressed to I. C. Winslow, chairman board of county commissioners, was handed to me with the request that I should furnish you with such data as I could gather regarding the number of irrigating ditches constructed in the county of Uinta, together with the amount of land being and proposed to be irrigated by water therefrom. The total claims for water rights of record is about 400. There has been over 65,000 acres of land entered under the provisions of the desert-land act; about 25,000 acres under the homestead act; about 9,000 acres under the timber-culture act, and over 6,000 acres pre-emption cash entries. There are valid pre-emption filings of record, covering about 8,000 acres. Besides the foregoing, there is a large area of land embraced in the grant to the Union Pacific Railway Company, a portion of which is susceptible of irrigation. There are also many settlers living upon unsurveyed lands, holding squatters' claims.

In the summer of 1886, I measured one hundred and eight ditches in this county, to ascertain their carrying capacity. This work was done by order of the board of county commissioners under Territorial law. I found the aggregate carrying capacity of said ditches to be 516 cubic feet per second of time, being sufficient to irrigate about 50,000 acres of land.

A great number of ditches have been constructed since the date of my official survey, of which I am unable to give you reliable data.

I think it would be safe to say, however, that fully 100,000 acres of lands in this county are now covered by irrigating ditches, but during the present unprecedented dry season the water supply has been deficient, and a partial failure of crops has been the result. It is surprising how productive some of our sage-brush lands can be made by proper cultivation and irrigation. I will cite the case of a small tract of 22 acres adjoining our town site, owned by A. V. Quinn. This tract has been carefully prepared and seeded to timothy and alfalfa, and thoroughly irrigated; two crops of hay have been harvested therefrom the present season, the first crop yielding about 3 tons per acre, and the second crop 2 tons per acre. The hay is worth $15 per ton.

There are many available sites for reservoirs for the storage of water to be used during the latter part of the irrigation season when the natural flow in the streams become deficient.

In my judgment these storage reservoirs should be located as near the head of the natural stream as practicable. Using small valleys for reservoirs at points where the fall in the stream is but slight, by the erection of dams of moderate height, storage room can be made for large bodies of water.

I know of one point on Bear River where it is practicable to construct a dam not exceeding 25 feet in height at a cost of less than $5,000, where storage room can be obtained for over 800,000,000 cubic feet of water, not interfering with any vested rights. Doubtless suitable sites for reservoirs can be found upon the most of the large natural streams of our county.

As to the amount of land within our county which would or could be made susceptible of irrigation by additional water supply, it is a question that can only be solved by ascertaining the amount of water that can be stored for that purpose.

With our present and prospective water supply it is probable that over one-half of the arable lands in our county will ever be reclaimed and cultivated.

WM. HINTON.

Mr. HOLDEN. Mr. William Hinton, who signs that letter, was the surveyor of the county at the time those ditches were surveyed.

The CHAIRMAN. What is the character of the crops produced in that county? There is nothing said in that statement about the production of wheat.

Mr. HOLDEN. The altitude of that county has rather been considered too great to make grain-growing a profitable branch of farming, and for that reason not a great deal of grain has been sown as compared with the vast amount of ground used for meadow-land.

The CHAIRMAN. Has the experiment been tried?

Mr. HOLDEN. Yes. On the Fontenelle, last year for the first time, a neighbor of mine raised about 30 acres of oats. I have lived the greater part of my life in the State of Illinois, and I can safely say I never saw a better crop of oats in Illinois than was grown there. As a result, there was about 100 acres put out on the Fontenelle this present season.

Director POWELL. Whereabouts on the Fontenelle is that?

Mr. HOLDEN. The Fontenelle is only settled up from the mouth about 12 miles. There is a cañon in the foot-hills, and this settlement is all below the foot-hills. The creek is fenced for about 12 miles. The ranches average in width from a half a mile to a mile wide, and those lands are nearly all of them under irrigation. It was estimated last year that there was in the neighborhood of 1,500 tons of hay raised on that creek.

Senator JONES. The land under cultivation is devoted mostly to hay?

Mr. HOLDEN. Yes; but, as I say, there were about 100 acres of wheat this year, and it turned out all right. I put out about 12 acres myself, and part of that was upon sage-brush land. We worked off that sage-brush with a machine moved by ten horses, and after breaking and tearing down the sage-brush and grease-wood the ground was then, without plowing, sowed with timothy and red-top. For that reason I did not plow it. Upon that ground I am thoroughly satisfied that I had about 2 tons of feed to the acre, grass and oats. The oats did not come up regularly. There would be spots that would be as nice as any place in the world, but there were vacant spaces also. If all was like the grown spaces there would be, I think, 50 bushels to the acre.

The CHAIRMAN. The small grains can then be raised in that county?

Mr. HOLDEN. Yes; and on the Bear River there is a great deal of oats, barley, and wheat raised.

The CHAIRMAN. At about what altitude?

Mr. HOLDEN. I think between 6,000 and 7,000 feet, from Evanston down to Cokeville, where the stream goes down into Idaho.

The CHAIRMAN. Is there anything further you wish to say?

Mr. HOLDEN. There is a point that perhaps I might mention. At

the upper end of this cañon (I speak of the foot-hills) a reservoir might be constructed at a small cost, and an immense body of water might be stored. There is a basin 4 or 5 miles wide and 10 or 12 miles long, and a reservoir there would not interfere with any vested rights.

STAMEMENT OF JOHN W. HOYT, OF LARAMIE.

The CHAIRMAN. Will you be good enough to give the committee any facts in your possession that will be of interest in connection with the inquiry on which we are engaged?

Mr. HOYT. I may not be in possession of the exact facts which you desire.

The CHAIRMAN. Have you observed that crops can be raised on the Laramie Plains?

Mr. HOYT. Yes.

The CHAIRMAN. Tell us what you know about that.

Mr. HOYT. I simply know that the experiment has been made of producing the different cereals, wheat, rye, oats, and barley. The work was begun five years ago and proved successful; in some places even without irrigation. I presented more than five years ago, at the exposition at Denver, specimens of grains grown on the bottom lands just outside of Laramie City by Mr. Fee. That was a very large production of those grains. The experiment was not a large one, covering only perhaps 10 or 20 acres, but it was very satisfactory.

The CHAIRMAN. Has it been tried elsewhere in that valley?

Mr. HOYT. Yes, it has been tried elsewhere.

The CHAIRMAN. How is it with the vegetable crops?

Mr. HOYT. It is always successful. Potatoes are grown in the garden plats of the city of Laramie. The product is very fine and the yield very large.

The CHAIRMAN. Have you observed the flood waters of the Laramie that run to waste; are they large or not?

Mr. HOYT. There is a large amount of water in the spring season.

The CHAIRMAN. A good deal of snow falls upon the mountains?

Mr. HOYT. Yes; the streams have their sources in the Medicine Bow Range, and the streams very often are flooded and overflow at the banks, so that a very large amount of water could be saved at that season of the year that now goes to waste. If that could be stored (and there are natural basins in which it could be stored) the waters of the Big Laramie would be able, from a reservoir supply, to irrigate a large body of land. There are about 200,000 acres of beautiful land lying between the Big and Little Laramie Rivers, very rich, productive soil, which would produce very handsome crops of nearly every sort except Indian corn, if watered. There is already a ditch there taking some of the water of the Laramie, but there is a large quantity of water still in reserve, and there are natural basins in which the surplus could be stored when not needed.

The CHAIRMAN. Then, according to your observation, the Laramie Plains make a fair agricultural country?

Mr. HOYT. I have no question as to the possibility of producing fine crops there.

Senator JONES. What yield of crops do you get per acre?

Mr. HOYT. The specimens that I saw must have yielded 40 bushels to the acre, and they have claimed 50 bushels, I think, of wheat. Oats were produced in very large yields.

Senator JONES. Have you seen one crop of wheat grown?

Mr. HOYT. I have seen patches of wheat in a number of places.

Senator JONES. Is wheat grown to any considerable extent there?

Mr. HOYT. No; none of those crops, I ought to say, are grown to any considerable extent as yet. The water supply has not been sufficient and the persons who own the lands and would be encouraged under favorable conditions to commence the cultivation of crops have been delaying on account of the condition of the water supply.

Senator JONES. What is the yield of potatoes to the acre?

Mr. HOYT. I hear extravagant accounts. I may not be able to furnish exact data on that subject, but I hear of 300 and 400 bushels to the acre. No finer potatoes have ever been seen, I think.

The CHAIRMAN. Is there anything further that you wish to say?

Mr. HOYT. I do not know that there is. The vegetable crop, I ought to say, is very remarkable. The root crops are very fine. There is a beginning also in the cultivation of small fruits and even with apples, so that many of our people are beginning to think of planting fruits. I am speaking of the Laramie Plains especially.

STATEMENT OF H. A. COFFEEN, OF SHERIDAN.

The CHAIRMAN. In what part of the Territory is that?

Mr. COFFEEN. It is in the central-north part.

The CHAIRMAN. On what stream?

Mr. COFFEEN. At the head of the Town River and branches of the Poudre River.

The CHAIRMAN. Into what streams do Town River and Poudre River discharge their waters?

Mr. COFFEEN. Into the Yellowstone, I believe, in Montana. We are next to the line thereof on the north of this Territory.

The CHAIRMAN. Will you describe the county in which you live?

Mr. COFFEEN. The character of the soil is surprisingly rich under irrigation, as compared with the land in Illinois and Indiana, where I have formerly lived. The surface is undulating, so that the farms are mostly in valleys on the small streams, but the table lands on the hillsides are equally fertile when irrigated.

The CHAIRMAN. And they are not too precipitous to be cultivated?

Mr. COFFEEN. Not in many parts. In some places they would be too precipitous to be cultivated.

The CHAIRMAN. You say the soil is rich; what crops do people raise there?

Mr. COFFEEN. We are raising grains of the usual kinds, vegetables of high quality and in great abundance; also fruits. I wish to refer particularly to fruits. Wheat, oats, and barley are raised there by many farmers who have settled there. Our region is known in this Territory as a specially fine agricultural country. Corn is being raised now sufficient to supply almost all home needs for fattening pork. The increase of the growth of corn is doubling. Five years ago they scarcely knew that they could raise corn. I have heard people in the northern part of the county stating that they raised 60 to 80 bushels to the acre. It was rather astonishing, but I know the gentlemen and I think they are correct. Fifty to 53 bushels to the acre of wheat is accounted an average. Of barley I can not speak as to the average. Oats average 45 to 50 bushels to the acre, but there have been 100 bushels to the acre raised there in many instances. On Prairie Dog

Creek and some of the other smaller streams the average has been well up to 60 and 75 bushels to the acre.

The CHAIRMAN. Do you raise potatoes?

Mr. COFFEEN. Yes.

The CHAIRMAN. What is a good crop of oats?

Mr. COFFEEN. I fear I may not be able to state precisely the average, but they have been as much as any crops I have known in the country.

The CHAIRMAN. How is it as to fruits?

Mr. COFFEEN. Our farmers have been experimenting on fruits for a few years, and they find they can raise strawberries and raspberries. I am a little doubtful about blackberries. As to apples, at our agricultural fair last year one of my neighbors exhibited a half bushel or more of very fine varieties, such as the Duchess, the Oldenburg, and others,—good sized apples. This year there will be many farms where they will have from 1 to 6 and more bushels on very small places.

The CHAIRMAN. What do you say of the quantity of land susceptible of irrigation in your county?

Mr. COFFEEN. I do not feel competent to state that with any degree of correctness. We have probably 50,000 acres of land now under irrigation, much of it, however, in grasses.

The CHAIRMAN. You have as much as that under actual irrigation?

Mr. COFFEEN. I think we have. And we have probably 300,000 or 400,000 acres of land that can be irrigated with great profit.

The CHAIRMAN. Have you a water supply for this amount of land?

Mr. COFFEEN. Not without storage.

The CHAIRMAN. But with storage, have you?

Mr. COFFEEN. With storage, I believe we have an abundant water supply for that.

The CHAIRMAN. How many acres?

Mr. COFFEEN. I wish to give that with many degrees of allowance; 300,000 or 400,000 acres is what I have estimated.

The CHAIRMAN. What is the character of the streams you have in your county; are they large and numerous or otherwise?

Mr. COFFEEN. they are numerous, and are small streams, rushing down from the mountains.

The CHAIRMAN. From what range of mountains do they come?

Mr. COFFEEN. From the Big Horn Mountains. That is the first range, from which the snows melt away in May, generally. Then there is the back range, of which Cloud's Peak would be a representative, from which the snows melt away chiefly in June, but not entirely during the whole year. The snows remain in part during the whole year.

STATEMENT OF CHARLES H. BURRITT, OF BUFFALO.

The CHAIRMAN. In what part of the Territory is Buffalo?

Mr. BURRITT. In the northern portion, in the Poudre River drainage basin.

The CHAIRMAN. What have you to say of that county in regard to irrigation?

Mr. BURRITT. I can not give you any statistics of any value in reference to Johnson County alone. Johnson and Sheridan Counties, as the drainage map of Wyoming on the wall shows, are all in one drainage *basin. During* the last three years, as secretary of the North *Wyoming Fair* Association and secretary of the Immigration Board

for that part of the Territory, I have prepared careful statistics on that drainage basin.

The CHAIRMAN. Showing what?

Mr, BURRITT. Showing the number of acres under ditch, the number of ditches, and the number of acres irrigated, the number of acres graded, the amount of crops raised, etc.

The CHAIRMAN. And the amount of land susceptible of irrigation?

Mr. BURRITT. Yes.

The CHAIRMAN. Have you anything in the form of a written document?

Mr. BURRITT. I have a part of my immigration report.

The CHAIRMAN. Does it cover the whole Territory?

Mr. BURRITT. It covers all of Johnson and Sheridan Counties both east and west of the Big Horn Mountains. That west of the Big Horn is in the drainage basin of the Big Horn, but there is but a very small portion of that territory cultivated as yet.

The CHAIRMAN. Will you file your report?

Mr. BURRITT. Yes.

The CHAIRMAN. I would like to have you speak of the Big Horn country if you are familiar with it.

Mr. BURRITT. I am not so familiar with it as with the eastern side of the range.

The CHAIRMAN. Make to the committee such statement about it as will be useful to them.

Mr. BURRITT. As to the eastern side of the range, the creeks or principal streams, which are all forks, center about Cloud's Peak. It is the highest point of the Big Horn range of mountains. That range is a very wide and big range at the top. Around Cloud's Peak are a series of lakes from which all the streams coming down on the Big Horn and the Poudre River have their source. There is a large range of those mountains. Some of them are so arranged as that they could be used for storage reservoirs with very little expense. There are already four ditches taken from those lakes by private enterprise and dropped over into various branches of the "Clear Fork of Poudre River," or "Clear Creek," as it is called. By small expenditure a considerable number of acres of land could be irrigated in addition to what is already irrigated in the two counties on the east side of the range. The same is true of the west side of the range. The rivers that run into the Big Horn practically head in those lakes.

The CHAIRMAN. Have you ever made an estimate of the land that could be irrigated in the two counties by storing water?

Mr. BURRITT. In the two counties there are 6,200,000 acres. By preserving the water I have no doubt that it could be increased at least five times what it is at present. There are about 450,000 acres at present under irrigating ditches.

The CHAIRMAN. Is there water enough to supply that 450,000 acres?

Mr. BURRITT. There is, in an ordinary season. There has not been this season, on account of the light fall of snow last winter.

The CHAIRMAN. Can it be increased to that by conserving the water?

Mr. BURRITT. The present water supply, if properly distributed, would irrigate at least 640,000 acres. I think that by the construction of storage reservoirs in the Big Horn and preserving the waters, 2,000,000 or 2,500,000 acres can be irrigated, counting both sides of the range in Johnson and Sheridan Counties.

The CHAIRMAN. What do you say in regard to the character of the soil?

Mr. BURRITT. On the east side of the range it is a black sandy loam, very rich. On the western side of the range it is principally a red gypsum soil, very deceptive to look at, but very rich in the production of crops, being mixed with the loam.

Senator JONES. There are 45,000 acres under ditch you say?

Mr. BURRITT. Yes.

Senator JONES. How much is irrigated?

Mr. BURRITT. That is all under ditch and between 300,000 and 350,000 acres are already practically irrigated. The other portion—100,000,—is not yet fully reclaimed. It is mostly the second or third bench or mesa land.

The CHAIRMAN. Do you know what proportion of the 300,000 acres under irrigation is in grass and how much in other crops?

Mr. BURRITT. I have the exact figures for it. In 1887 there were 1,729 acres cropped to wheat; 7,816 cropped to oats. The amount cropped to barley was quite small—perhaps not over 150 or 200 acres. The oat and wheat portion has been increased very nearly if not quite 100 per cent. since that time. The barley area has probably been increased to 1,000 acres. About one-half the balance of the land was, in 1887, cropped to hay. That has been increased to about 75 per cent., owing to the lack of facilities for getting the products out of the country on account of the long distances from the railroads. The people have complied with the law, so far as is necessary, by the reclamation of the land, but have not expended much beyond, because they have not the opportunity to market the product. This is a short statement from my report.

The CHAIRMAN. Have you your report complete?

Mr. BURRITT. I have it here.

The CHAIRMAN. Can you furnish a copy of it to the committee?

Mr. BURRITT. Yes.

The CHAIRMAN. You may state the average crops shown by it.

Mr. BURRITT. The average crops in Sheridan and Johnston counties vary from 20 to 60 bushels of wheat; as high as 80 bushels of wheat has been raised to the acre, but of course such a crop as that was under particular cultivation. The average crop of wheat is about 30 bushels to the acre. It is a class of wheat that grades in Minneapolis and St. Paul as "A No.1," and makes a superior quality of flour. The average crop of oats is 50 to 60 bushels to the acre. On 5 acres on Crazy Woman Creek 105 bushels to the acre were raised. On Prairie-Dog Creek, north of Buffalo, 85 bushels to the acre was the crop of 1887, on 40 acres of ground. Barley was cultivated quite largely in the immediate vicinity of the town in which I live, and the crop runs from 40 to 60 bushels to the acre. The average is higher than the medium between those two. A common crop of potatoes is 200 bushel to the acre. A not extraordinary crop is 300 bushels, and on one tract of land near the city of Buffalo 650 bushels were raised on one acre which had been sage-brush and greasewood land. I saw it cleared myself and knew what it was. Corn was about as stated by Mr. Coffin. In the northern Wyoming fair we had five specimens raised in five different parts of Johnston and Sheridan counties of pieces of corn. The fair was held on the 7th and 8th days of September. All small fruits are easily cultivated. I do not think that the apple cultivation of Johnston and Sheridan counties, except in favored localities, will be a success; the winters freezing out the trees. I am not, however, as competent a judge of that as I am of other things.

STATEMENT OF NOYES BALDWIN, OF LANDER.

ıe CHAIRMAN. In what part of the Territory is Fremont County?
r. BALDWIN. In the northwestern portion. The northern boundary ur county is Montana. It embraces the headwaters of the Big n River.
he CHAIRMAN. Have you a map of that county?
r. BALDWIN. I have a map, of a portion of it.
he CHAIRMAN. How is it marked?
r. BALDWIN. It is marked "Plat of Popo Agie River and tributa- " The most thickly settled portion of the county is the vicinity of der.
he CHAIRMAN. Is Lander your county seat?
r. BALDWIN. Yes.
he CHAIRMAN. What streams run through your county?
r. BALDWIN. The Popo Agie, the Big Wind River, and the Little id River, which, after it passes through the cañon in the Big Horn ge, is then called the Big Horn River. It has many tributaries.
he CHAIRMAN. Have you irrigation in your county?
r. BALDWIN. We have 108,000 acres under ditch now, in this sec- . Then there is a considerable portion north that I know very little it.
ıe CHAIRMAN. How much of the land under ditch is actually culti- d?
r BALDWIN. Probably 50,000 or 60,000 acres.
ıe CHAIRMAN. What is the character of the crops raised there?
r. BALDWIN. All the small grains and vegetables grown in other ions of our Territory. The vegetable crop is a very productive crop.
ıe CHAIRMAN. What is about the altitude of that valley?
r. BALDWIN. About 5,500 feet.
ıe CHAIRMAN. That is about the average altitude of the valley ion of it?
r. BALDWIN. Yes.
ıe CHAIRMAN. All the small grains and vegetables are raised there?
r. BALDWIN. Yes.
he CHAIRMAN. What is the character of the soil?
r. BALDWIN. Excellent. The bottom land is loam and the bench s are sandy and gravely soil.
ıe CHAIRMAN. Have you a water supply to irrigate all the 108,000 s under ditches?
r. BALDWIN. Yes, we have an ample supply of water.
ıe CHAIRMAN. What amount of land in Fremont County is suscep- of cultivation?
r. BALDWIN. There is a very large portion of it. It will be difficult stimate it all.
ıe CHAIRMAN. Compared with what is under ditch, how much? Is half of it under ditch?
r. BALDWIN. It is, in this immediate vicinity of Lander; but the ıty is a very large county. It embraces about two thousand square s. The northern portion of it I am not very well acquainted with.
ıe CHAIRMAN. Are the valleys large?
r. BALDWIN. Yes; very large.
ıe CHAIRMAN. Is the water supply good?
r. BALDWIN. It is abundant. The streams are mountain streams, are fed from the mountains.

The CHAIRMAN. Are there lakes there?

Mr. BALDWIN. There are large lakes at the heads of those streams.

The CHAIRMAN. Furnishing opportunities for storage?

Mr. BALDWIN. Yes. There are narrow cañons from which these streams mostly flow.

The CHAIRMAN. You have no means of actually estimating the extent of country that could be brought under cultivation?

Mr. BALDWIN. No; but it would amount to many hundred thousand acres.

The CHAIRMAN. You may add anything now that you desire.

Mr. BALDWIN. We raise all manner of grasses here, such as alfalfa, timothy, red-top. We raise two and three crops of alfalfa each year. The yield of wheat each year is about 40 bushels to the acre, and about 45 to 50 bushels of oats to the acre. Potatoes and every kind of vegetables grow to great perfection and the yield is abundant.

STATEMENT OF ANDREW GILCHRIST, OF CHEYENNE.

The CHAIRMAN. What is your occupation?

Mr. GILCHRIST. I am a banker, a ranchman, a cattle-raiser, and an agriculturist.

The CHAIRMAN. Where do you reside?

Mr. GILCHRIST. In Cheyenne.

The CHAIRMAN. In what portion of the Territory are you pursuing agriculture?

Mr. GILCHRIST. In Laramie County.

The CHAIRMAN. The committee will be glad to hear any statement you may wish to make in regard to the water supply, the land to be irrigated, and the crops that can be produced in Laramie County.

Mr. GILCHRIST. In the spring of the year, when there is a flood, the water from the mountains comes down, and there is sufficient for about a month or six weeks. In that period we get considerable water from Dale Creek, Crow Creek, Pole Creek, Horse Creek, Bear Creek, Sybille Creek, the Laramie River, and the Platte.

The CHAIRMAN. Are the waters of the Platte exhausted?

Mr. GILCHRIST. No; the water of the Platte is not exhausted at present through Laramie County, for the reason that it flows through quite a cañon and in a deep valley, and there is very little of the land along the Platte River in Laramie County that is susceptible of irrigation.

The CHAIRMAN. You have to go lower down on the Platte to use these waters?

Mr. GILCHRIST. Either lower down or higher up; probably lower down. Before it enters into Nebraska there are some lands susceptible of irrigation in the Goshen country.

The CHAIRMAN. Is there any opportunity to increase the water supply so as to furnish sufficient to irrigate these 300,000 acres that are under ditch.

Mr. GILCHRIST. Yes; there are good opportunities at the head of the Laramie River and also at the head of the Platte. I believe there are good storage basins there that could be used to preserve the waters in the flood time and bring it down to Laramie County to utilize on the land susceptible of irrigation.

The CHAIRMAN. Have any efforts been made to store the water?

Mr. GILCHRIST. Not any up to this time, of any consequence.

The CHAIRMAN. How much land is actually under cultivation in Laramie County?

Mr. GILCHRIST. There are about 150,000 acres actually irrigated.

STATEMENT OF DELEGATE JOSEPH M. CAREY, OF CHEYENNE.

The CHAIRMAN. You are the Delegate to Congress from this Territory?

Mr. CAREY. Yes.

The CHAIRMAN. How long have you resided in the Territory of Wyoming?

Mr. CAREY. Twenty years.

The CHAIRMAN. Are you familiar with its general characteristics as to the lands susceptible of irrigation, the water to irrigate it with, and the land that is already irrigated, and what has been done in that line?

Mr. CAREY. I have a general knowlege of the Territory. Of course I have no statistics at hand, but tables have been prepared by the Territorial engineer showing the acreage under cultivation, etc.

The CHAIRMAN. He has the acreage under ditches, but not the amount cultivated.

Mr. CAREY. Owing to the prevailing business of the Territory a very large portion of the land that is irrigated is cultivated for hay, especially in sections of the country where there are no markets for grain. A good deal of time is spent in cropping it, storing it, and baling for the market, when there is a market, and feeding it to the stock in the winter. I can not tell the acreage that is actually plowed and cultivated during the year. I think Professor Mead can approximate that.

Mr. MEAD. I could do so with a little time. I have not prepared that for the committee now.

The CHAIRMAN. Will you send it to the committee?

Mr. MEAD. Yes.

The CHAIRMAN. The cattle industry is a large industry in this Territory.

Mr. CAREY. Cattle-raising was, I believe, the first business in this Territory, with coal mining.

The CHAIRMAN. You have other mines besides coal mines?

Mr. CAREY. We have gold and some silver and copper deposits and very large iron deposits.

The CHAIRMAN. The farming, as I understand you, in the portion of the Territory best adapted for farming, is remote from the railroads.

Mr. CAREY. The best country for farming in this Territory (because it is easy to irrigate it) is, I should say, comprised in Sheridan, Johnston, Fremont, and Crook Counties, which, as you see, are in the northeastern portion of the Territory. Sheridan is in the northern part and Johnston comes down toward the center. Fremont County is being cultivated south of the Wind River Reservation, which you see in the outline of Greene. There is some farming up north of the reservation on the Big Horn River.

The CHAIRMAN. The stock-raisers in the Territory are, then, turning their attention to cultivating the land and raising forage for stock?

Mr. CAREY. There is a great deal of forage raised by the stockmen.

The CHAIRMAN. They have ceased to rely wholly on the range for their winter supply?

Mr. CAREY. There is still a great deal of range business in the Territory, where cattle and horses are kept without putting up any hay whatever. Other stockmen put up considerable material which they feed to their cattle in winter. It is becoming quite general in this Territory, where men have cattle of more than ordinary value, or cattle that hap-

pen to be thin in the fall of the year, that they wish to [redacted] tion as that they can have their own feed.

The CHAIRMAN. The cattle industry is growing, is it, [redacted]

Mr. CAREY. Yes, very rapidly. The greatest number of [redacted] ployed for strict farming, is, I suppose, in the counties I [redacted] There are a good many people carrying on the grange busine[redacted] verse County and Laramie County and Albany County—in [redacted] all the counties.

The CHAIRMAN. Has any considerable attention been [redacted] storage of water and increasing the water supply for [redacted] poses?

Mr. CAREY. Not to any great extent. I can not say th[redacted] been a great deal of attention given to it, yet it is carried [redacted] extent, especially around this town.

The CHAIRMAN. From what has been done around this [redacted] do you say of the opportunities in this Territory of increasing [redacted] supply by the various methods suggested for storage?

Mr. CAREY. There is every opportunity for it. So far as I [redacted] able to see, nature has favored us in that respect, because [redacted] spaces where great storage and great lake basins can be for[redacted] small cost. Natural depressions are found where the const[redacted] dam will, if placed across a very narrow cañon, make a very [redacted] in which large quantities of water can be accumulated.

The CHAIRMAN. It was stated by the Territorial engin[redacted] the amount of arable land that can be brought under cu[redacted] irrigation, if the water were stored reasonably well, was c[redacted] from 5,000,000 to 10,000,000 acres of land. Have you know[redacted] about the estimates?

Mr. CAREY. I place every reliance upon Professor Mead[redacted] He is a very conservative man.

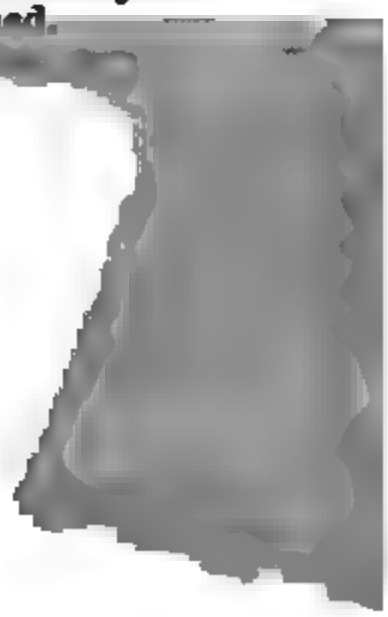
The CHAIRMAN. He has given himself 5,000,000 acres[redacted] latitude.

Mr. CAREY. He is not as liable to exaggerate about [redacted] some people who are holding up to the world all the ti[redacted] wealth of the Territory in which we live; but I heard Major [redacted] an estimate before the Committee on the Territories of the [redacted] resentatives at Washington. He estimated that there [redacted] water precipitated in this territory, if it could all be acc[redacted] saved, to reclaim about one-fifth of the area of the Terr[redacted] would amount to 12,000,000 or 13,000,000 acres. From wh[redacted] right at this town, as to the amount of water that we [redacted] a very small stream, I am inclined to believe that Majo[redacted] overestimated the amount that may be reclaimed.

Mr. MEAD. The question [redacted] was the opinion in [redacted]

The CHAIR[redacted] timate yours[redacted]

Mr. CAR[redacted] most of th[redacted] ming, ha[redacted] ridges and [redacted] near th[redacted] reason [redacted]



STATEMENT OF LIONEL SARTORIS, OF LARAMIE.

The CHAIRMAN. Have you ever been engaged in irrigation in Albany County?

Mr. SARTORIS. I have been irrigating there for the last six years.

Mr. CHAIRMAN. How near Laramie City?

Mr. SARTORIS. About 20 miles west of Laramie City, on the Little Laramie River.

The CHAIRMAN. What crops do you raise?

Mr. SARTORIS. For the last two years, oats, wheat, and a little barley. We tried alfalfa this year for the first time. Oats have been our principal crop there. Last year 44 bushels to the acre was the yield. That was the first year and we were very short of water. This year I am just cutting oats (we have not thrashed out yet), but I do not think it will be very much better on account of the early frost we had about a week ago. In a good year I think we could thrash 60 to 80 bushels to the acre.

The CHAIRMAN. Would wheat succeed here?

Mr. SARTORIS. Wheat would be an undoubted success, but of course, people will not grow what they can not get a market for.

The CHAIRMAN. How about barley?

Mr. SARTORIS. We grew such a small piece last year that we did not measure it.

The CHAIRMAN. Do you grow potatoes?

Mr. SARTORIS. About 15 acres this year.

The CHAIRMAN. How much did you get of those?

Mr. SARTORIS. I have not measured them.

The CHAIRMAN. Is the water supply abundant?

Mr. SARTORIS. Yes, when there is plenty of snow in the timber. This year the water has been somewhat short.

The CHAIRMAN. Does it run to waste in the flood season?

Mr. SARTORIS. Yes; because there is hardly anybody up in the country that knows anything about how to irrigate the land properly. If we had people there that understood irrigation there could be ten times the amount of land used that is irrigated now.

The CHAIRMAN. How much water do they use to irrigate?

Mr. SARTORIS. I do not know exactly.

The CHAIRMAN. They flood the land, do they?

Mr. SARTORIS. Yes.

The CHAIRMAN. Have you ever been engaged in irrigation elsewhere?

Mr. SARTORIS. No.

The CHAIRMAN. Have you any other remark which you desire to make?

Mr. SARTORIS. No; except about the possibility of storing water up there. There are enormous facilities in that part of the county for making reservoirs. It can easily be done.

The CHAIRMAN. Is there enough snow falling and enough preciptation generally to fill reservoirs if they were constructed?

Mr. SARTORIS. Yes; except in very exceptional years such as last year, when scarcely any snow fell at all. The soil there is as good as any part of the world I think. It is a light sandy loam, composed chiefly of silica and lime, and will grow anything you please except corn.

STATEMENT OF M. M. GRANT, OF LARAMIE.

The CHAIRMAN. We would like to have such information as you possess in regard to irrigation in this Territory, and the opportunities for it.

Mr. GRANT. In Albany County I think there could be about 400,000 acres of land irrigated by ditch and by storage reservoirs. I believe it could even be doubled.

The CHAIRMAN. You think 800,000 acres could be brought under cultivation?

Mr. GRANT. Yes, by storage reservoirs.

The CHAIRMAN. Could sufficient water supply be got for 800,000 acres?

Mr. GRANT. I think so. There's another thing I wanted to state in connection with that, which I regard as being very important. That is, the preservation of the timber from forest fires. Timber has a greater bearing on the preservation of water than anything else; it holds the snows. I think I can safely say that in our county there has been at least twenty times as much timber destroyed by fire as there has been cut by settlers. Those fires are very destructive, and I think should be guarded against. I regard that as being very important.

The CHAIRMAN. Have you any suggestion to make as to how to accomplish that?

Mr. GRANT. I think there should be timber reservations set aside in these mountains. I think there should be a timber commissioner, and that he should be vested with authority to employ men to help him to suppress forest fires when they start and, if possible, to compel the people to assist him. Of course they should have proper compensation. I believe that with proper watching these fires if taken in time are easy to stop. There are millions of dollars' worth of timber that has been destroyed in the Territory. It is a matter that I think bears very strongly on the question of irrigation.

The CHAIRMAN. It undoubtedly does.

Mr. GRANT. As to the storage of water in Albany County. There are a great many places where dams could be placed for storing water. In fact, in nearly all of those streams where they come out of the mountains there are good opportunities for water storage. I believe that the area that could be irrigated would be doubled.

The CHAIRMAN. You think it could be increased to 800,000?

Mr. GRANT. I think so.

The CHAIRMAN. And it is good land for all sorts of crops, small grains and vegetables?

Mr. GRANT. Yes; especially for hay. There is no place anywhere in the world where you can grow finer hay than in that section. I should think from 30,000 to 40,000 tons of hay are grown in that county. I have been over nearly all the Territory and I am satisfied from my observation (and I have lived here for twenty years) that there could be at least 5,000,000 acres of land irrigated without storage reservoirs, and I believe that by storage reservoirs that it could be doubled.

The CHAIRMAN. Ten millions, you think, could be irrigated by storage reservoirs?

Mr. GRANT. Yes.

The CHAIRMAN. Mr. Mead did not make an estimate himself, but stated what the estimate of the people was?

Mr. GRANT. Yes.

The CHAIRMAN. Your estimate then is, that through storage, there are 10,000,000 acres of land in the Territory that can be brought under cultivation?

Mr. GRANT. Yes; and I think this could be further increased by boring artesian wells.

The CHAIRMAN. That is a new experiment, but probably might be done to some extent.

Mr. GRANT. Yes; probably 300,000 or 400,000 acres, if the water could be had. It would depend upon whether the water could be had or not.

STATEMENT OF J. A. JOHNSTON, OF LARAMIE.

The CHAIRMAN. Where do you reside?

Mr. JOHNSTON. In Laramie, Wyo.

The CHAIRMAN. What is your occupation?

Mr. JOHNSTON. It has been for the last twelve or fourteen years constructing and operating irrigation works.

The CHAIRMAN. And in what portions of the Territory?

Mr. JOHNSTON. I have operated in Colorado; but for the last five years I have been employed in this Territory.

The CHAIRMAN. What do you say in regard to the water supply for irrigation, the land to be irrigated, and the result of irrigation in Wyoming generally?

Mr. JOHNSTON. I am not familiar with any portion of it but Laramie County and some little in Albany County.

The CHAIRMAN. State what the opportunities are there for obtaining water, and what the land is that is to be irrigated.

Mr. JOHNSTON. That has been covered pretty well by Mr. Gilchrist, who has spoken before me. He has stated the number of streams, etc. The Laramie River is the place where I was operating. I constructed works to reclaim about 60,000 acres of land about 100 miles north from here.

The CHAIRMAN. Have you a sufficient supply of water to irrigate the 60,000 acres?

Mr. JOHNSTON. In ordinary seasons we have.

The CHAIRMAN. Without storage?

Mr. JOHNSTON. Yes, in ordinary seasons. The water is taken out in what is known as the Laramie range. We also get seepage from the lower plains, after the water has been used there, and from the small streams that come in from the Laramie range.

The CHAIRMAN. What is your opinion in regard to developing more water—as by storage and improvement of the streams?

Mr. JOHNSTON. It could be greatly developed, not only by storing the waters, but by securing the waters that have under-currents. My observation has been that most of the streams are underlaid with bed-rock, and that by tapping the streams at the bed-rock we could secure an increased flow of water almost invariably. We have an example of that in the water-works of this town. We would be practically without water to-day on account of the dryness of the season if it were not for having applied that system. I made some observations recently on the heads of the North Platte and the Laramie Rivers, and I believe there is in that vicinity at high altitudes on the summits of these ranges and on the plateaus great facilities for storing water, immense facilities at very slight expense. I have also had some experience in crops in this county. I have raised crops on these lands that I speak of for the last

two or three years, and have demonstrated to my satisfaction that they will produce all the cereals—rye, wheat, oats, and good corn—that is, north of here, at the altitude of about 4,800 feet. We have raised there from 30 to 60 bushels of oats, 30 to 40 bushels of wheat; barley we have never tried, but we have raised from 30 to 60 bushels of corn of good quality; some of it is on exhibition at the fair at this present time; also potatoes and other vegetables in that vicinity, which will compare favorably with anything grown east or west.

STATEMENT OF GOVERNOR FRANCIS E. WARREN.

The CHAIRMAN. You are the present governor of this Territory?

Mr. WARREN. Yes.

The CHAIRMAN. How long have you resided in the Territory?

Mr. WARREN. Nearly twenty-two years.

The CHAIRMAN. Have you directed your attention to agriculture by means of irrigation?

Mr. WARREN. To some extent, yes.

The CHAIRMAN. You have heard the statements made here this evening. The committee would be glad to have from you any statement that you think would be useful in the inquiry that it is making on this subject.

Mr. WARREN. My observation of the Territory of Wyoming has been that while there is a great deal of land under irrigation and the smaller streams and valleys have been quite generally utilized, yet as a matter of fact the Territory has been scarcely scratched as to the possibilities that may result from a system of irrigation which would provide for the use of the waters that rise within the boundaries of the Territory. And when I speak of using the waters that rise within the boundaries of the Territory, I do so without prejudice to the States and Territories around us in cases where the streams flow out into them. On the other hand, I think it would be as much a benefit to them as to this Territory if a system of irrigation and storage could be devised that would provide for the storage of our waters, and also provide for the taking out of the large streams where expensive work is required, and for the storing back of the flood waters in the winter, and allowing the water necessary for crops to flow out during the summer or irrigating season. That would not only secure the flood waters at the time they come, but would also secure the waters to our contiguous Territories and States. We have in Wyoming the heads of almost all the streams that run to the Mississippi. They run largely into both Montana and Nebraska.

The CHAIRMAN. You have the sources of the streams in very high mountains, too, have you not?

Mr. WARREN. Yes. One-fifth to one-seventh of this Territory is capable of raising crops if water is provided. I believe one-seventh would be a safe estimate. There are about 64,000,000 acres in the Territory. (I am not giving this from statistics or close figuring, but as a matter of observation and general information.) The greater portion of the waters run away at flood times—run down the large streams and sink in the sand outside of the Territory and are not used at present. Irrigation has heretofore been confined principally to small ditches easily taken out. That arises first from the fact of its being a newly settled country, and secondly from the United States land laws, which have not provided for corporate work. When I say corporate work I mean that the expenditure of large sums for reservoirs and canals for

taking out the water from the large streams would certainly be the most successful way of irrigating, but the land can only be procured at the present time by various claims under the law, and it is difficult to assemble enough land at any one point to guaranty and make profitable the taking out of large ditches and the storing of the waters.

The CHAIRMAN. We have found some instances where corporations and individuals have constructed ditches and sold the water rights sometimes in advance of construction at so much money for a quantity of water or so much money for enough to irrigate a given quantity of land, selling it outright to those who hold the land, making the contracts as they went along and arranging it so that when they got through the water belonged to the land-owners. Has that been tried in this Territory?

Mr. WARREN. Not to a large extent, and I do not think it would be as successful in the early portion of the settlement of the Territory as it would be later on. We have not yet arrived at that stage. If a company can get a guaranty that they can get a profit on their money by immediate introduction of the water on their land they will expend money for the purpose.

The CHAIRMAN. Would you think it wise to have the land owned by one set of owners and the ditch by another, who would rent the water from year to year?

Mr. WARREN. The most successful schemes that I have observed have been where the corporation has been prepared to do both. It has had some land of its own and has sold such water as there was a demand for, using the residue upon lands that it might itself own. Of course I do not speak of that to recommend the ownership of large blocks of land by private individuals and private corporations in advance of the actual taking out of the water. But if the State or Territory could own bodies of land which might pass into the hands of others as soon as reclaimed by them, I think no harm could come from its being passed out in larger bodies than 40 acres, or 80 acres, or 160 acres.

The CHAIRMAN. The result that you would want would be to get settlers on small quantities.

Mr. WARREN. That is it. But that result is hard to attain at present under the land laws and with the water so that the ditches, etc., can only be taken out in a small way.

The CHAIRMAN. Would a careful survey, determining where reservoirs could be located, ascertaining the amount of the water supply by gauging the rivers and measuring the rain-fall and also determining as nearly as practicable the amount of land to be irrigated, the estimate of cost, etc., be valuable to this Territory?

Mr. WARREN. It would be valuable, but to get that definite information would probably require a good deal of time, whereas sufficient knowledge is already had to warrant the feasibility of a storage system and the taking out of water from the large streams by canals, etc. While the survey would be valuable as I say, the practicability of the work is already proved. We have the natural basins and we have good soil.

The CHAIRMAN. Would the reservoirs or basins be generally on public land or would they be on private land in this Territory?

Mr. WARREN. Those that are nearest to the head of the streams and on the mountains would be on public lands entirely.

The CHAIRMAN. The designation of those, then, would be important to private enterprise at once?

Mr. WARREN. Yes. It might sometimes appear that those reservoirs should be in the valley where the streams would run through, yet it

often happens that a canal, by rounding the bluffs, flows into large natural basins that would be more successful in every way than to have reservoirs placed on the stream.

The CHAIRMAN. Is it not important to have these surveys made to show the storage sites as they are to be reserved?

Mr. WARREN. Yes.

Senator JONES. I believe you said awhile ago that the use in the Territory of Wyoming of all the water lying in the Territory of Wyoming would be beneficial to other States.

Mr. WARREN. Yes; I certainly think so.

Senator JONES. Please explain your view in detail in regard to that.

Mr. WARREN. Take the case of a stream flowing water enough when the ditches are first taken out to irrigate, we will say, 500 acres. By taking the water out farther away from the stream and higher up, irrigating little by little, the land that is irrigated forms itself to some extent a reservoir. That is, I have in mind now a stream in Colorado which was barely sufficient to irrigate 1,000 acres ten or twelve years ago, but which now, by the establishment of a system of ditches carried wider out, irrigates 30,000 or 40,000 acres. While they are all the time taking out water from above the lands below are becoming more wet. The water soaks into the land and gets out again and goes on down, and the water is more continuous in the season by being used. Take any stream where the water passes down at 10 or 12 miles an hour and a shower comes up. It is only a little while until it has passed down. There may be floods in the rivers or the water may be taken into the soil in the process of irrigation; nearly all of it finds the level of the stream again and therefore makes a continuous flow.

Senator JONES. That is on the hypothesis that all the water taken from the stream finds its way back?

Mr. WARREN. Partly.

Senator JONES. I thought the fact was that considerable water was taken up by the plant life, that with much irrigation there was a material decrease in the amount of water, and that if the process was kept on long enough not a drop of water would, after awhile, be found. So that, if my idea is correct, it would seem to be possible that if all the water rising in Wyoming should be used to the fullest extent that it might be used there would be a deprivation of the other States.

Mr. WARREN. I do not propose to explain it scientifically, but observation demonstrates what I have said. I have observed this also, the plant life appears to provide in great measure for itself. We have no dew here, for example, on the prairies, yet if we go into a growth of wheat or grass in the morning we find that there is considerable moisture. The plants are wet. Explain it as we may, the plant seems to provide for itself.

The CHAIRMAN. Your idea is that it would increase the rain-fall or the amount of moisture in the atmosphere?

Mr. WARREN. I believe there is no question of that. With irrigation a certain percentage of it will be taken up at first by the soil, but almost all of it will get back to the river if we save the water at times when all along the stream there is a superabundance of it, and use the spare water on the land.

The CHAIRMAN. The advantage, then, you think is in the uniformity of the flow?

Mr. WARREN. Partly. I suppose you have visited Fort Collins and probably you have evidence from there, but I remember when all the water of the Poudre River was used to irrigate less than 1,000 acres.

You know what a vast territory it irrigates now. The head waters have not increased at all. Go to the head of Cachéla Poudre and if anything, ycu will find less water there now than formerly, owing to the destruction of timber.

Senator JONES. Then how is the water increased?

Mr. WARREN. It is increased in its irrigating capacity.

Senator JONES. Do you mean to say that the volume of water has been increased or that it is used over and over again?

Mr. WARREN. I mean to say that it is used over and over again; and that the soil takes it in the spring, at the flood time, while it formerly went down the stream uninterrupted.

Senator JONES. I have no doubt that your idea is correct, that there will be more uniformity in the flow.

Mr. WARREN. I do not mean to assert that it will make the aggregate flow in twelve months any larger. I do not believe that any more water will reach the sea in the course of a year, but it will flow more uniformly.

Senator JONES. And your idea is that it will be an advantage to all the States outside of Wyoming?

Mr. WARREN. Yes.

Senator JONES. If it should be the fact that plant-growth and aerial evaporation do lessen the volume of water to such an extent that the arid lands of Wyoming would consume all the water in the Territory, then there would be no benefit to the other States from the use of the water here?

Mr. WARREN. No matter how fully we would use the water in Wyoming, I can not conceive of any system that would not benefit the surrounding States and Territories. It is possible that some evidence may have been adduced, or may be offered, showing that the Platte River has less water east of here on account of irrigation. In answer to that, I should say that if it is so, it is because the water is largely taken out in the first year's irrigation of large tracts of land. If you take out a stream and distribute the water over a great area, it will show less water the first season for a few miles below, but it never fails, later, to irrigate sufficiently with less water. There is one stream I know of that has been controlled by one company for eight or ten years. Originally that was a stream coming from springs that would run down about fifty rods, probably, and sink again. At many points that stream would be totally dry for three months in the year. They have taken out the water, and at the present time the water is not used at all upon what was formerly irrigated land, but is spread on the hillside. What was formerly irrigated is now ditched, and the water is taken from there. That is a surplus of water which is carried down the hill, so that the purpose is to drain out the water down below.

Senator JONES. There have been a number of instances where streams have been dried up before irrigation, but which have since become full.

Mr. WARREN. I say this very frankly that if I were a citizen of Nebraska or any other State, and had interest in the waters that flowed from Wyoming, I would be glad to see irrigation practiced just as extensively as the water would warrant.

The CHAIRMAN. In other words you would like to have the waters kept back and stored in the land rather than have them come down in the flood time.

Mr. WARREN. Yes.

Mr. HOYT. You would expect to suffer for a year or two?

Mr. WARREN. Yes, except on some large stream where very large operations could be conducted. But as a general thing the operations on any one stream would not be felt.

The CHAIRMAN. While you are filling the soil it would certainly be felt, but when you got the soil once filled it would operate to make the land need less irrigation?

Mr. WARREN. Yes.

Governor Warren filed with the committee the Irrigation laws of Wyoming, which are as follows:

TITLE 19. *IRRIGATION.*

CHAPTER 1. *Rights to use of water and right of way for ditches.*
CHAPTER 2. *Appropriation of water—Procedure.*
CHAPTER 3. *Official survey of ditch.*

CHAPTER 1.

RIGHTS TO USE OF WATER AND RIGHT OF WAY FOR DITCHES.

Sec.
1317. Rights of riparian owners.
1318. When land owner entitled to right of way—Damages.
1319. Extent of right of way.
1320. Petition to commissioners—Notice of appointing appraisers.
1321. Proceedings of appraisers—Payment of assessment.
1322. Owner may raise water from stream.
1323. Ditches to be kept in repair.
1324. Vested rights preserved.
1325. Ditches to be bridged.
1326. When commissioners to bridge ditches—Expenses.
1327. Claim for right of way may be arbitrated.
1328. Appointment and proceedings of arbitrators.
1329. Appeal to commissioners.
1330. If no appeal taken, award is final.

SEC. 1317. All persons who claim, own, or hold a possessory right or title to any land or parcel of land within the boundary of Wyoming Territory, when those claims are on the bank, margin or neighborhood of any stream of water, creek, or river, shall be entitled to the use of the water of said stream, creek, or river for the purposes of irrigation and making said claim available to the full extent of the soil for agricultural purposes. [C. L. 1876, ch. 65, § 1.]

SEC. 1318. When any person owning claims in such locality has not sufficient length of area exposed to said streams to obtain a sufficient fall of water to irrigate his land or his farm, or land used by him for agricultural purposes is too far removed from said stream, and he has no water facilities on those land he shall be entitled to a right of way through the farms or tracts of land which lie between him and said stream, or the farms or tracts of land which lie above and below him, on said stream, for the purposes hereinbefore stated: *Provided*, That, in the construction, keeping up, and using any ditch through the lands of another person, the person or persons constructing or using said ditch, or whose duty it shall be to keep the same in repair, shall be liable to the person owning or claiming such land, for all damages accruing to such person by reason of said construction, keeping up, and using such ditch. [C. L. 1876, ch. 65, § 2.]

SEC. 1319. Such right of way shall extend only to a ditch, dyke, or cutting sufficient for the purposes required. [C. L. 1876, ch. 65, § 3.]

SEC. 1320. Upon the refusal of the owners of tracts of land, or lands through which said ditch is proposed to run, to allow of its passage through their property, the persons desiring to open such ditch may present to the county commissioners of the county in which said lands are located, a petition, signed by the person or persons, describing with convenient accuracy the lands so required to be taken as aforesaid, setting forth the name or names of the owner or other person interested, and praying the appointment of three appraisers to ascertain the compensation to be made to such owner or persons interested. Upon the receipt of said petition, the said county commissioners shall give notice, at least thirty days prior to the appointment of said appraisers, by public notice in a newspaper, when published in the county or by posting three or more notices in three different places in said county, stating that such appraisers will be appointed on the———day of———. [C. L. 1876, ch. 65, § 5.]

SEC. 1321. The said appraisers, before entering upon the duties of their office, shall take an oath to faithfully and impartially discharge their duties as said appraisers. They shall hear the proofs and allegations of the parties, and any two of them, after reviewing the premises, shall, without fear, favor, or partiality, ascertain and certify

the compensation proper to be made to said owner or persons interested, for the lands to be taken or affected, as well as all damages accruing to the owner or person interested, in consequence of the condemnation of the same, taken or injuriously affected as aforesaid, making such deduction or allowance for real benefits or advantages which such owner or parties interested may derive from the construction of said ditch or flume. They or a majority of them shall subscribe a certificate of their said ascertainment and assessment, which shall be recorded in the county clerk's office of the county in which said lands are situated, and upon the payment of the compensation (if any), the said person or persons shall have the right of way of construct said ditch or flume. [C. L. 1876, ch. 65, § 6.]

SEC. 1322. All persons on the margin, bank, neighborhood, or precinct of any stream of water shall have the right and power to place upon the bank of said stream a wheel or other machine for the purpose of raising water to the level required for the purpose of irrigation, and the right of way shall not be refused by the owner of any tract of land upon which it is required, subject, of course, to the like regulations as required for ditches and laid down in the last preceding section. [C. L. 1876, ch. 65, § 7.]

SEC. 1323. The owner or owners of any ditch for irrigation or other purposes shall carefully maintain the embankments thereof, so that the waters of such ditch may not flood or damage the premises of others. [C. L. 1876, ch. 65, § 8.]

SEC. 1324. Nothing in this chapter contained shall be so construed as to impair the prior vested rights of any mill or ditch owner, or other person, to use the waters of any such water-course. [C. L. 1876, ch. 65, § 9.]

SEC. 1325. Any ditch company constructing a ditch, or any individual having ditches for irrigation or for other purposes, whenever the same be taken across any public highway or public traveled road, shall put a good substantial bridge (not less than fourteen feet in breadth), over such water-course where it crosses said road. [C. L. 1876, ch. 65, § 11.]

SEC. 1326. When any such ditch or water-course shall be constructed across any public traveled road, and not bridged within three days thereafter, it shall be the duty of the county commissioners of the county in which said ditch and road are located to put a bridge over said ditch or water-course, of the dimensions specified in the foregoing section, and call upon the owner or owners of the said ditch or water-course to pay the expenses of constructing said bridge, and if payment therefor be refused, a civil action may be maintained for the recovery of the same, together with all accruing costs. [C. L. 1876, ch. 65, § 12.]

SEC. 1327. Upon the refusal of the owner or owners of land or lands through which any person or persons are desirous of constructing any irrigation ditch or ditches, then it shall be lawful for the parties interested to settle the matter by the appointment of a board of arbitration consisting of three men as hereinafter provided. [S. L. 1882, ch. 57, § 1.]

SEC. 1328. The creation of the board of arbitration shall be as follows: The person or persons desiring the construction of such ditch or ditches and the owner or owners of the land or lands through which the construction of such ditch or ditches is contemplated shall each choose one disinterested resident property holder of the county in which the land or lands mentioned above are situated, and the two so chosen shall designate a third person with like qualifications as themselves, and it shall be lawful for these persons to immediately proceed to hear the proof and allegations of the parties concerned. It shall be lawful for any two of such board of arbitration to make such assessment of damages as may in their judgment be deemed just and right, taking into consideration the benefits, if any, that may accrue to the owner or owners of the land or lands through which the construction of such ditch or ditches is contemplated. [S. L. 1882, ch. 57, § 2.]

SEC. 1329. Should the verdict or assessment of such board of arbitration be unsatisfactory to either or both of the parties interested, then recourse may be had by an appeal made in writing within ten days from the rendering of such verdict by such board of arbitration, addressed to the board of county commissioners of the county in which the contestants reside, in which case the party taking the appeal shall give bonds for all the costs; then the case shall stand as though no action had been taken in the matter and the parties may then proceed under this chapter in the same manner as though the proceedings to ascertain the compensation to be given had been taken before the county commissioners in the first instance. [S. L. 1882, ch. 57, § 3.] (For proceedings before commissioners see §§ 1320 and 1321.)

SEC. 1330. In case no appeal be taken as above provided by either of the parties interested, then the finding of such board of arbitration shall be binding and final; *Provided*, The sum of money agreed upon by the board of arbitration has been tendered or paid, or a deed for such right of way executed and delivered or tendered by the party or parties over whose land the right of way is sought. [S. L. 1882, ch. 57, § 4.]

CHAPTER 2.

APPROPRIATION OF WATER—PROCEDURE.

Sec.
1331. Irrigation districts defined and numbered.
1332. Appointment of water commissioners.
1333. Oath of commissioners.
1334. Duties of commissioners.
1335. Molesting head-gates, etc.—Penalty—Commissioners may make arrests.
1336. Compensation of commissioners.
1337. Employment of assistant commissioners—Compensation.
1338. Commissioners to perform duties only when necessary.
1339. Jurisdiction of courts to settle water rights.
1340. Statement of existing water rights to be filed, etc.
1341. Filing and index of statement.
1342. Fees of clerk of court.
1343. Statement of contemplated ditch—Apportionment of water—Construction to begin in sixty days.
1344. Streams open to appropriation.
1345. Manner of determining priority of water rights in district court.
1346. Notice of trial of rights to water.
1347. Destroying water improvements—Penalty.
1348. Appeal to supreme court—Notice—Undertaking.
1349. Service of notice in case of appeal.
1350. Transcript to be filed in six months.
1351. Decree of supreme court.
1352. Effect of failing to offer evidence of priority of water rights.
1353. Effect of failure to file statement of water right.
1354. Decision may be reviewed in district court.
1355. Right of persons constructing reservoirs.
1356. Liability of owners of reservoirs.
1357. Fees of witnesses.
1358. Rights of incorporated companies to take water.
1359. Water commissioners to prevent waste of water.
1360. Ditch owners to protect fish.
1361. Vested rights preserved.

SEC. 1331. The lands now irrigated, or which may be hereafter irrigated, from ditches taking water from the following described rivers and natural streams of the Territory of Wyoming, are hereby declared to constitute irrigation districts:

District number one shall consist of all lands irrigated from ditches from the North Platte River and its tributaries, except the Laramie River, between its intersection with the boundary line between Nebraska and Wyoming and its intersection with the western boundary line of Laramie County, Crow Creek, Lone Tree Creek, Pole Creek, Horse Creek, Chugwater Creek, Cheyenne River, Niobrara or Running Water River, and their tributaries.

District number two shall consist of all lands irrigated from ditches taking water from the Laramie River and tributaries, except Chugwater Creek, North Platte River and its tributaries, between its intersection with the western boundary line of Laramie County and the mouth of the Sweetwater, Sabille Creek and North Laramie Creek; and also the following-named streams, situate in whole or in part in the County of Albany, namely: Douglass Creek, Lake Creek, the three Beaver Creeks, Four-Mile Creek, Dutton Creek, Cooper Creek, Rock Creek and tributaries, Sabille, Sheep Creek, Deer Creek and tributaries, Antelope Creek, Fish Creek and its tributaries, Dale creek and its tributaries, and also the following-named lakes, to-wit: Cooper Lake, James Lake, Ione Lake, Sportsman's Lake, Lake Hutton, Lake Creighton, Lake George, Steamboat Lake, Horse Creek Lake, Lake Hattie, and Lake Owen.

District number three shall consist of all lands irrigated from ditches taking water from the North Platte River and its tributaries to the line of Carbon County, and all streams or continuations of streams lying within Carbon County.

District number four shall consist of all lands irrigated from ditches taking water from the Green River and its tributaries.

District number five shall consist of all lands irrigated from ditches taking water from the Powder, Tongue, and Big Horn Rivers and their tributaries, except Wind River.

District number six shall consist of all lands irrigated from ditches taking water from the Little Powder River, Little Missouri River, and the Belle Fourche and their tributaries.

District number seven shall consist of all lands irrigated from ditches taking water from that portion of Green River lying within Uinta County and Bear River.

District number eight shall consist of all lands irrigated from ditches taking water from Wind River to Johnson County line.

Other irrigation districts may be formed from time to time by the governor, on petition of the parties interested, comprising territory not within any of the above-established irrigation districts. [S. L. 1886, ch. 61, § 1.]

SEC. 1332. There shall be one water commissioner for each of the above-named districts, and for each district hereafter formed, who shall be appointed by the governor, to be selected by him from persons recommended to him by the several boards of county commissioners of the counties into which water districts may extend, and the water commissioners so appointed shall hold their office for two years, or until their successor is appointed and qualified. The governor, by like selection and appointment, shall fill all vacancies which may be occasioned by death, resignation, or con-

tinued absence from the district, removal or otherwise, and the governor may at any time remove any water commissioner for failure to perform his duties, or for any other cause. [S. L. 1886, ch. 61, § 2.]

SEC. 1333. Within twenty days after his appointment, and before entering upon the duties of his office, such water commissioner shall take and subscribe an oath to faithfully and impartially perform the duties of his office, which oath shall be deposited with the clerk of the court having jurisdiction over the priority of rights to use of water in his district. [S. L. 1886, ch. 61, § 3.]

SEC. 1334. It shall be the duty of the said water commissioners to divide the water in the natural stream or streams of their districts among the several ditches taking water from the same, according to the prior rights of each, respectively, in whole or in part, and to shut and fasten, or cause to be shut and fastened, the head-gates of any ditch or ditches heading in any of the natural streams of the district, which in time of a scarcity of water, makes it necessary, by reason of the priority of the rights of others above or below them on the stream. [S. L. 1886, ch. 61, § 4.]

SEC. 1335. Every person who shall willfully open, close, change, or interfere with any head-gate or water-box without authority shall be guilty of a misdemeanor, and on conviction thereof shall be fined in any sum not exceeding one hundred dollars, or imprisoned in the county jail for a term not exceeding six months, or both fine and imprisonment. The water commissioners or their assistants, within their districts, shall have authority to arrest any person or persons offending and turn them over to the sheriff of the proper county. [S. L. 1886, ch. 61, § 5.]

SEC. 1336. The water commissioners herein provided shall be entitled to pay at the rate of five dollars per day for each day he shall be actually employed in the duties of his office, not to exceed fifty days in any one year, to be paid by the county in which his irrigation district may lie. Each water commissioner shall keep a just and true account of the time spent by him in the duties of his office, and shall present a true copy thereof, verified by oath, to the board of county commissioners of the county in which his district may be, and said board of county commissioners shall allow the same, and if said irrigation district shall extend into two or more counties then said water commissioner shall present his account for his said services, verified as aforesaid, to the board of county commissioners of the county in which sits the district court having jurisdiction over the priorities of the rights to use of water for the purposes for which it was appropriated in such districts. [S. L. 1886, ch. 61 § 6.]

SEC. 1337. Said water commissioners shall have power, in case of emergency, to employ suitable assistants to aid him in the discharge of his duty; such assistants shall take the same oath as the water commissioner and shall obey his instructions, and each shall be entitled to four dollars per day for every day he is employed, not to exceed thirty-five days in any one year, to be paid upon the certificate of the water commissioner in the same manner as is provided for payment of water commissioners. [S. L. 1886, ch. 61, § 7.]

SEC. 1338. Said water commissioners shall not begin their work until they shall be called on by two or more owners or managers, or persons controlling ditches in the several districts, by application in writing, stating that there is a necessity for their action, and they shall not continue performing services after the necessity therefor shall cease. [S. L. 1886, ch. 61, § 8.]

SEC. 1339. For the purpose of hearing, adjudicating, and settling all questions concerning the priority of appropriation of water, between ditch companies and other owners of ditches, drawing water for beneficial purposes, from the same stream, or its tributaries, within the same irrigation district, and all other questions of law and questions of right growing out of or in any way involved or connected therewith, jurisdiction is hereby vested, exclusively in the several district courts, as follows: For district number one, in the district court of Laramie County; for district number two, in the district court of Albany County; for district number three, in the district court of Carbon County; for district number four, in the district court of Sweetwater County; for district number five, in the district court of Johnson County; for district number six, in the district court of Crook County; for district number seven, in the district court of Uinta County; for district number eight, in the district court of Fremont County. All streams, lakes, and reservoirs not herein enumerated shall be, for all purposes, attached to and belong to the irrigation district in which the greater portion of its water is, it being the intent and meaning hereof to add to each irrigation district all waters not hereinbefore enumerated the majority of which lie in their respective are as, for the purposes of acquiring rights to the appropriation and use thereof and adjudicating the same. [S. L. 1886, ch. 61, § 9.]

SEC. 1340. In order that all parties may be protected in their lawful rights to the use of water for beneficial purposes, every person, association or corporation, owning or claiming any interest in any ditch, canal, or reservoir, within any water district shall, on or before the first day of September, eighteen hundred and eighty-six, if such statements are not already matters of record at the time this act is approved,

file with the clerk of the district court having jurisdiction of priority of rights to the use of water for irrigation, in such water district, a statement of claim, under oath, entitled of the proper court, which statement shall contain the name or names, together with the post-office address of the claimant or claimants claiming ownership, as aforesaid, of any such ditch, canal, or reservoir, the name thereof (if any), and if without a name, the owner or owners shall choose and adopt a name, to be therein stated, by which such ditch, canal, or reservoir, shall thereafter be known. The description of such ditch, canal, or reservoir as to location of head-gate, general course of ditch, the name of the natural stream from which such ditch, canal, or reservoir draws its supply of water, the length, width, depth and grade thereof, as near as may be, the time, fixing a day, month and year, as the date of appropriation of water by original construction, also by any enlargement or extension, if any such thereof have been made, and the amount of water claimed by or under such construction, enlargement or extension, and the present capacity of the ditch, canal, or feeder, or reservoir, and also the number of acres of land lying under and being, or proposed to be, irrigated by water from such ditch, canal, or reservoir; or if such waters have been appropriated for other beneficial purposes than irrigation, a statement of such purpose; such statement shall be signed by the proper party or parties; and shall file with the county clerk and *ex-officio* register of deeds a like statement, which shall be be recorded by him in a book kept for that purpose. [S. L. 1886, ch. 61, § 10.]

SEC. 1341. Upon the filing of such statement, the clerk of the court shall endorse upon the back thereof the date of filing, and shall prepare an index of the same, in a book to be provided for that purpose by the county commissioners, which said index shall contain the date of filing, the name of the party, association, or corporation, the name of the ditch, the stream from which the water is taken by such ditch, canal, or reservoir, in general terms, the location of the head-gate, the date of the appropriation of the water, by construction, enlargement or extension; said index shall be prepared alphabetically, by reference to the name of the ditch, canal, or reservoir. [S. L. 1886, ch. 61, § 11.]

SEC. 1342. For filing and indexing such statement, the clerk of the court shall receive a fee of one dollar, to be paid by the party or parties filing the same. [S. L. 1886, ch. 61, § 12.]

SEC. 1343. Hereafter every person, company, or corporation, constructing, enlarging, or extending any ditch, canal, or reservoir, for beneficial purposes, and intending to use or appropriate any water from any natural stream within a water district, for such beneficial purposes, shall file with the county clerk and *ex-officio* register of deeds and the clerk of the district court, of the proper county, before the commencement of the construction, enlargement, or extension of such ditch, canal, or reservoir, a statement showing the stream or streams from which the water is to be taken; the point or place on said stream at or near which the water is to be taken out; the line of said ditch or ditches as near as may be; the use or uses to which said water is intended to be applied; the dimensions of such ditch or ditches, and each thereof, giving width on bottom and top, slope of banks, and grade of ditch; and likewise of any and all enlargements thereof; which statement shall be filed and indexed as is provided in section thirteen hundred and forty, and from the time of filing any such statement water sufficient to fill such ditch or ditches, and to subserve the use or uses aforesaid, if a lawful and just use, shall be deemed and adjudged to be appropriated; *Provided*, That nothing herein contained shall be permitted to interfere with a prior right to said water, or to any thereof; *And provided further*, That such person or persons, or corporation, shall within sixty days next ensuing the filing of such statement, begin the actual construction of said ditch or ditches, and shall prosecute the work of the construction thereof diligently and continuously to its completion; *And provided further*, That the beginning of all necessary surveys of such ditch shall be construed as the beginning of said work of construction. [S. L. 1886, ch. 61, § 13.]

SEC. 1344. The water of every natural stream not heretofore appropriated within this Territory is hereby declared to be the property of the public and the same is dedicated to the use of the people, subject to appropriation as herein provided. The provisions of this chapter shall apply to all cases where water of natural streams is appropriated for beneficial purposes, whether the water be conducted through ditches, canals, flumes or tunnels, and shall apply also to cases where for irrigation purposes the water is stored in reservoirs and the owner or owners of any ditch, canal, flume or tunnel through which water is conducted for irrigation purposes, and also the owners of reservoirs may conduct the water therefrom into and along any of the natural streams of the Territory, but not so as to raise the waters thereof above high water mark, and may take the same out again at any point desired, but due allowance shall be made for evaporation and seepage, the amount to be determined by the water commissioner of the proper district, subject to review and determination by the court having jurisdiction over priorities in such district. [S. L. 1886, ch. 61, § 14.]

SEC. 1345. Whenever any person or persons, association or corporation, interested as owners of any ditch, canal, or reservoir, in any district, shall desire a determina-

tion of the priorities of rights to the use of water from stream or streams, from which they draw the water for their ditch or ditches, canals or reservoirs, they shall present to the district court having jurisdiction over the rights in such water district, or to the judge thereof in vacation, a motion, petition or application in writing, moving or praying said court to proceed to an adjudication of the priorities of rights to the use of water for irrigation, between the several ditches, canals or reservoirs in such district, on the stream or streams named in the motion, petition or application. The said motion, petition or application shall state the names of the ditches, canals or reservoirs, claiming water from said stream or streams, as appears by the final statements in the clerk's office, together with the names of the persons, associations or corporations interested therein, taken from said statements, and shall set forth the nature of the claim or claims of the applicant or applicants, and such motion, petition or application shall be entitled "in the matter of an application for an adjudication of the priorities of rights to use water for beneficial purposes in water district number ——, on ——" (stating the stream or streams). Upon the filing and docketing of such application, the court, or judge thereof, in vacation, shall without unnecessary delay, by an order to be entered of record, upon such motion, petition or application, appoint a day, in some regular term of said court, or in vacation thereof, for commencing to hear and take evidence in such adjudication, at which time it shall be the duty of the court, or judge thereof in vacation, to proceed and hear all evidence that may be offered by or in behalf of any person, association or corporation interested in such stream or streams in such district, in any ditch, canal or reservoir, either as owner or consumer of water therefrom, in support of or against any claims of priority of appropriation of water made by means of any ditch, canal or reservoir, or by an enlargement or extension thereof in such district, or on such stream or streams, and consider all such evidence, also the arguments of the parties or their counsel, and shall ascertain and find from such evidence, as near as may be, the date of the commencement of such ditch, canal or reservoir, together with the original size and carrying capacity thereof, as originally constructed, the time of the commencement of each enlargement or extension thereof, if any, with the increased capacity thereby occasioned, the time spent severally in such construction, enlargement, or extension and re-enlargement, if any, the diligence with which the work was in each case prosecuted, the nature of the work as to the difficulty of construction, and all such other facts as may tend to show the compliance with the law in acquiring the priority of right claimed for each such ditch, canal or reservoir, and determine the matters put in evidence, and make and cause to be entered, a decree determining and establishing the several priorities of right, by appropriation of water of the several ditches, canals and reservoirs, in such water district, in such stream or streams, concerning which testimony shall have been offered, each according to the time of its said construction and enlargement or enlargements and extensions, with the amount of water which shall be held to have been appropriated by such construction and enlargement, or extensions, describing such amount by cubic feet per second of time (which shall also be the method of measurement for the sale of water), if the evidence shall show sufficient data to ascertain such cubic feet, and if not, by width, depth and grade, and such other description as will most certainly and conveniently show the amount of water intended, as the capacity of such ditch, canal or reservoir in such decree. Such court or judge thereof, in vacation, shall further order that each and every person interested or claiming any such ditch, canal or reservoir, shall receive from the clerk on payment of a reasonable fee therefor, to be fixed by the court or judge, in vacation, a certificate under seal of the court, showing date or dates, and amount or amounts of appropriations adjudged in favor of such ditch, canal or reservoir, under and by virtue of the construction, extension and enlargement thereof severally, also specifying the number of said ditch as determined by the court, with reference to priority, and of each priority to which the same may be entitled by reason of said construction, extension and enlargement; *Provided*, That any party or parties claiming any right to the use of water for beneficial purposes in such district, and on such stream or streams, by reason of being owner of or interested in any ditch, canal or reservoir, who is not mentioned in the motion, petition or application filed and presented to the court, shall be notified by the clerk of such application, and shall become parties to such proceedings, and shall have their rights adjudicated therein. The court or judge thereof, in vacation, may, instead of taking the testimony orally or in open court, refer the matter to some person to take and reduce to writing the testimony to the court or judge thereof, in vacation, and the person to whom such cause shall be referred for that purpose, shall have the same power and duties concerning the taking of testimony, and compelling the attendance of witnesses, as masters in chancery. [S. L. 1886, ch. 61, § 15.]

SEC. 1346. Upon the order of the court fixing the time of hearing being made, the clerk shall place a certified copy of such order, which order shall contain the names of all the parties alleged in application to be interested in the matter, in the posses-

sion of the sheriff of the proper county, which shall be thereupon served upon each of the parties therein named in the same manner as a summons, and a return of the service shall be made and filed with the clerk within fourteen days after the delivery of said order to the sheriff, or if served by any other person, in cases where a summons could be served, then return shall be made within fourteen days after date of order. It shall be the duty of the clerk also to give public notice of such application and order, by publication in a newspaper, if any be printed and in circulation, in some county wherein such water district is situated, which notice shall be published at least once each week for two consecutive weeks, and which said notice shall contain the date of the filing of said motion, petition, or application, the name or names of the parties filing the same, a copy of the order made by the court for hearing, and shall notify all parties interested as owners in any ditch, canal, or reservoir on such stream or streams in such water district, as well as the persons named in the motion, petition, or application, to appear at said court or before the judge thereof, in vacation, at the time appointed and stated in the order, and that all persons interested as owners or consumers may then and there present his, her, or their proofs for or against any priority of right of water by appropriation sought to be shown by any party, by or through any ditch, canal, or reservoir (either as owner or consumer of water drawn therefrom), and in case any party mentioned in the motion, petition, or application can not be personally served in any county embraced in such water district, the published notice above provided shall be deemed sufficient service of notice: *Provided further*, That in addition to such publication the clerk shall mail such published notice to each party mentioned in the motion, petition, or application, directing the same to the address of such parties as stated in the sworn statement on file. Proof of the proper publication shall consist in the sworn certificate of the publisher of the paper in which notice is published, to which shall be attached a printed copy taken from such paper. [S. L. 1886, ch. 61, § 16.]

SEC. 1347. Any person or persons who shall knowingly and willfully cut, dig, or break down, or open any gate bank, embankment, or side of any ditch, canal, or reservoir, flume, tunnel, or feeder in which such person or persons may be joint owners, or on the property of another, or in the lawful possession of another or others, and used for the purpose of irrigation, milling, manufacturing, mining, or domestic purposes, with intent maliciously to injure any person, association, or corporation, or for his or her own gain, unlawfully, with the intention of stealing, taking, or causing to run, or pour out of such canal, or reservoir feeder, or flume, any water for his or her own profit, benefit, or advantage, to the injury of any other person, persons, association, or corporation lawfully in the use of such water, or of such ditch, canal, tunnel, feeder, or flume, he, she, it, or they, so offending, shall be deemed guilty of a misdemeanor, and, on conviction thereof, shall be fined in any sum not exceeding one hundred dollars, and may be imprisoned in the county jail not exceeding six months, or both, at the discretion of the court. [S. L. 1886, ch. 61, § 17.]

SEC. 1348. Any party or parties, representing any ditch, canal, or reservoir, or any number of parties, representing two or more ditches, canals, or reservoirs, which are affected, in common with each other, by any portion of the decree rendered by the district court, by which he, she, it, or they may feel aggrieved, may have an appeal from said district court to the supreme court, and in such case the party or parties joining, desiring an appeal, shall be the appellants, and the parties representing any one or more ditches, canals, or reservoirs affected in common, adversely to the interests of appellants, shall be appellees. The party or parties in such appeal shall, within sixty days after the date of the decree, file in the district court wherein any decree is entered under this chapter a notice of appeal in writing, stating that such party or parties appeals to the supreme court of the Territory from the decree rendered in the case, or any part thereof. When only a part of the decree is appealed from the notice of the appeal should so state, and shall also in that case specify the portion or part of the decree appealed from. Upon filing of such notice of appeal the cause shall be deemed to be appealed to the supreme court of the Territory: *Provided, however*, That the party or parties appealing as aforesaid, shall, within sixty days aforesaid, enter into an undertaking, to be approved by the district court, or judge thereof, and to be given to all parties in said suit or proceeding, other than the parties appealing, and to be in such an amount as the court or said judge shall fix, conditioned that the parties giving their said undertaking shall prosecute their appeal to effect, and without unnecessary delay, and will pay all costs and damages which the parties to whom the undertaking is given, or either or any of them may sustain in consequence of such appeal. [S. L. 1886, ch. 61, § 18.]

SEC. 1349. The order last aforesaid shall be entered of record, and the appellant or appellants shall cause a certified copy thereof to be served on each of the appellees, by delivering the same to him or her, if he or she may be found, or otherwise serving the same, in manner the same, as may be provided for serving summons from the district court by the laws then in force. [S. L. 1886, ch. 61, § 19.]

SEC. 1350. The appellant or appellants shall, within six months after the appeal be allowed as aforesaid, file in the office of the clerk of the supreme court of this Ter-

ritory a certified transcript of the proceedings had in the case in the district court containing the pleadings and the statements of the parties filed herein and all evidence of record offered on the hearing of the cause, or so much thereof as shall effect the appropriation of water claimed by the means of construction, enlargement, or re-enlargement of the several ditches, canals, and reservoirs mentioned in the order allowing the appeal. When the evidence has been taken in the open court, or before the judge, in vacation, such evidence, or the substance thereof, reduced to writing and signed by the judge, or in case notes of said testimony have been taken by the official stenographer, a transcription of the same, signed by the stenographer and attested by his official seal, filed with the clerk of the court, shall be deemed a record of the evidence taken in said court. [S. L. 1886, ch. 61, § 20.]

SEC. 1351. The supreme court, in all cases heard before it under this chapter, shall, where it can properly be done, render such decree as the court, or the judge below, should have rendered. It may either reverse or modify the decree of the court or judge below, and in cases where the decree of the court below is reversed, in whole or in part, it may direct the court below as to its further proceedings therein. [S. L. 1886, ch. 61, § 21.]

SEC. 1352. No claim of priority of any person, association, or corporation on account of any ditch, canal, or reservoir, as to which he, she, it, or they have failed or refuse to offer evidence, under any adjudication herein provided for, shall be regarded by any water commissioner in distributing water in times of scarcity thereof, until such time as such party shall have by application to the court having jurisdiction obtained leave and made proof of the priority of right to which such ditch, canal, or reservoir shall be justly entitled, which leave shall be granted in all cases upon terms as to notice to other parties interested, and upon payment of all costs, and upon affidavit or petition sworn to, showing the rights claimed, and the ditches, canals, and reservoirs, with the names of the owners thereof, against which such priority is claimed, nor until a decree adjudging such priority to such ditch, canal, or reservoir has been entered, and certificate such as mentioned in section thirteen hundred and forty-six shall have been issued to claimant and presented to the water commissioner. [S. L. 1886, ch. 61, § 22.]

SEC. 1353. No person, association, or corporation representing any ditch, canal, or reservoir shall be permitted to give or offer any evidence before said court until he, she, it, or they shall have filed a statement of claim in substance the same in all respects as is required to be filed under the provisions hereof. [S. L. 1886, ch. 61, § 23.]

SEC. 1354. The district court, or judge thereof, in vacation, shall have power to order for good cause shown, upon terms just to all parties, and in such manner as may seem meet, a re-argument or review, with or without additional evidence, of any decree made under the provisions of this chapter, whenever said court or judge shall find from the cause shown for that purpose by any party or parties feeling aggrieved, that the ends of justice will be thereby promoted, but no such review or reargument shall be ordered unless applied for by petition or otherwise within two years of the time of entering the decree complained of. [S. L. 1886, ch. 61, § 24.]

SEC. 1355. Persons desiring to construct and maintain reservoirs for the purpose of storing water shall have the right to take from any of the natural streams of the Territory and store away any unappropriated water not needed for immediate use, for domestic or irrigation or other beneficial purposes, to construct and maintain ditches, canals, flumes, or tunnels, for carrying such water to and from such reservoirs, ditches, canals, tunnels, and flumes, in the same manner provided by law for the condemnation of lands for right of way for ditches: *Provided*, No reservoir with embankments or a dam exceeding ten feet in height shall be made without first submitting the plans thereof to the county commissioners of the county in which it is situated, and obtaining their approval of said plans: *And provided, further*, That no such reservoir shall be constructed or made in or across the channel of any natural and running stream. [S. L. 1886, ch. 61, § 25.]

SEC. 1356. The owners of reservoirs shall be liable for all damage arising from leakage or overflow of the waters therefrom, or by floods caused by breaking of the embankments of such reservoir. [S. L. 1886, ch. 61, § 26.]

SEC. 1357. Every witness who shall attend before the court, or the judge thereof in vacation, or before the person appointed to take testimony, in the causes provided for in this chapter, under subpœna, by request of any party, shall be entitled to the same fees and mileage as witnesses in civil cases in the district court, and shall be paid by the party requiring his testimony. [S. L. 1886, ch. 61, § 27.]

SEC. 1358. It shall not be necessary for any corporation heretofore organized and now existing, or for any corporation hereafter organized, under the laws of this Territory, which has heretofore, or shall have hereafter constructed, operated, or maintained any ditches, canals, flumes, tunnels, or reservoirs, or other appropriations of water, for the purpose of irrigation, mining, manufacturing, domestic uses, or for any beneficial purpose whatever, to incorporate as a ditch company, or companies, if the objects or purposes for which such corporation shall have been formed or incorporated,

imply, permit, or make necessary, or advantageous, such use or uses of water; and such corporation for all the purposes of this chapter shall have all the rights of a natural person as defined herein, and shall have its rights determined in the same manner: *Provided*, No priority of water right shall take from any city or town the water required for the use of the the residents thereof. [S. L. 1886, ch. 61, § 28.]

SEC. 1359. Said water commissioners shall so divide, regulate, and control the use of the water of all streams within their respective districts in such manner, as near as may be, as will prevent unnecessary waste of water, and to that end such commissioners shall so shut and fasten the head-gate or gates of all ditches so that no more water will flow into said ditch than is actually required and will be used for the uses or purposes for which such water was appropriated, and any person who may be injured by the action of any water commissioner or by his failure to act pursuant to this chapter, may resort to any court of competent jurisdiction for such relief as he may be entitled to. [S. L. 1886, ch. 61, § 29.]

SEC. 1360. It shall be the duty of every person, corporation, or company, who shall construct, maintain, or operate any ditch or canal under the provisions of this chapter to construct and maintain, at the point and place where the water is diverted from its natural channel, some fit and proper obstruction whereby all fish will be prevented from entering said ditch or canal. Any person, company, or corporation violating the provisions of this section shall be adjudged guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not more than one hundred dollars or by imprisonment in the county jail not less than ten nor more than sixty days, or by both such fine and imprisonment. [S. L. 1886, ch. 61, § 30.]

SEC. 1361. This chapter shall in no wise be construed as impairing or abridging any rights already vested in any person or persons, company or corporation, by virtue of the law heretofore in force. [S. L. 1886, ch. 61, § 31.]

CHAPTER 55.

IRRIGATION—APPROPRIATION OF WATER—TERRITORIAL ENGINEER.

AN ACT creating the office of Territorial engineer and concerning appropriation of water.

Be it enacted by the Council and House of Representatives of the Territory of Wyoming:

SECTION 1. There shall be a Territorial engineer, who shall be appointed by the governor, by and with the consent of the legislative council; he shall hold his office for the term of two years, commencing on the first day of April, A. D. eighteen hundred and eighty-eight, and until his successor shall be appointed and shall have qualified.

The governor may at any time, upon good cause being shown, remove the Territorial engineer, and fill the vacancy occasioned by such removal from office.

The Territorial engineer shall receive a salary of two thousand and five hundred dollars per annum, payable in monthly installments by the Territorial treasurer, upon warrants drawn by the Territorial auditor.

The Territorial engineer shall keep his office at the Territorial capitol, in a room in the capitol building, to be set aside for his use by the governor.

Before entering upon the duties of his office he shall take and subscribe an oath before some officer authorized by the laws of this Territory to administer oaths, to faithfully perform the duties of his office, and file with the secretary of the Territory said oath and his official bond, in the penal sum of five thousand dollars, with not less than two sureties to be approved by the governor of the Territory, and conditioned for the faithful discharge of the duties of his office, and for delivering to his successor, or other officer appointed by the governor to receive the same, all moneys, books, and other property belonging to the Territory then in his hands, or under his control, or with which he may be legally chargeable, as such officer. No person shall be appointed as such Territorial engineer who is not known to have such theoretical knowledge and practical skill and experience as shall fit him for the position.

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for the storage of waters in those portions of the Territory where such a system is practicable, stating in such report the location, capacity, and cost of such reservoirs; he shall become conversant with the water-ways of the Territory, and needs of the Territory as to irrigation matters, and in his report to the governor he shall make such suggestions as to the amendment of existing laws, or the enactment of new laws, as his information and experience may suggest; and he shall keep full and proper records of his works, observations, and calculations, all of which shall be the property of the Territory.

SEC. 4. The Territorial engineer shall, onrequest of any party interested, measure and ascertain the carrying capacity of any ditch used for irrigation or other beneficial purposes, which may be now, or which may hereafter be constructed or enlarged, and give to the party or parties requiring such services an official certificate of the size and carrying capacity of such ditch, expressed in cubic feet per second of time, as he shall find it at the time of measuring the same. For such services he shall be entitled to receive from the party or parties requiring the same his per diem charges, not exceeding ten dollars per day, and his reasonable traveling expenses: *Provided*, That all per diem charges for such services received by the Territorial engineer shall be delivered by him to the Territorial treasurer, who shall credit the same to the general fund. If the applicant or applicants for such engineer's certificate shall state in writing to the engineer that the ditch to be measured is so remote from the office of the engineer as to render the expense of the engineer's personal examination too great, or if in the engineer's judgment such ditch is too far distant to prevent him, consistently with his public duties, to make such personal examination, it shall in such cases be his duty to appoint some competent civil engineer, residing in the vicinity of such ditch, to make a sworn statement setting forth the width on top and bottom, depth, grade, and slope of the bank of such ditch or its enlargement, and all such other data concerning such ditch so to be measured as the Territorial engineer shall direct. Such civil engineer shall receive for his services such sum as may be agreed upon between himself and the party requiring his services, but in the absence of any agreement in writing such compensation shall not exceed ten dollars per day and his reasonable traveling expenses. The Territorial engineer shall furnish the person so appointed with blank certificates upon which to enter the necessary data concerning the ditch or its enlargement, so to be measured, which blank shall be properly filled out and verified by the oath of the party making such measurements and returned to the Territorial engineer, who shall make his own calculations of the carrying capacity of such ditch or enlargement, expressed in cubic feet per second of time, and certify to the same. The certificates provided for in this section shall set forth the time of making the measurement, the location of the headgate of the ditch measured, the name of the natural stream of water from which such ditch draws its supply of water, the width of such ditch both on top and on bottom, its depth and grade, and its carrying capacity expressed in cubic feet per second of time, and also the name of the ditch and of the owner or owners thereof, if known. All such certificates shall be recorded at length in the office of the said Territorial engineer, and copies of such record duly certified to by the said engineer, shall be received in all the courts of this Territory, as prima facie evidence of the fact therin set forth, as hereby required.

SEC. 5. The Territorial engineer, with the consent of the governor, shall have power to employ assistants at an expense not to exceed one thousand dollars in any one year, who shall be paid out of any moneys appropriated for that purpose, on the certificate of said Territorial engineer, approved by the governor, showing the reason for such employment, the services rendered, and the amount thereof, and on presentation of such certificate to the Territorial auditor, by the person entitled thereto, he shall issue his warrant on the territorial treasurer for the amount thereof to be paid ont of any appro priation, as aforesaid, and not otherwise.

SEC. 6. When the Territorial engineer is called away from his office in the discharge of his public duties, he shall be entitled to his actual traveling expenses, which shall be paid out of any money appropriated for that purpose, on the certificate of the said engineer; such certificate shall be presented by the said engineer to the Territorial auditor, who shall thereupon draw his warrant upon the Territorial treasurer for the amount thereof, to be paid out of such appropriation: *Provided*, That this section shall not be so construed as to authorize the payment of traveling expenses to said engineer when called away from his office to perform any of the work mentioned in section four of this act.

SEC. 7. The appropriator of any of the public waters in this Territory shall construct and maintain, under the direction of the Territorial engineer, a flume or other measuring device, at or as near the head of his ditch as is practicable, for the purpose of assisting the water commissioners in determining the amount of water that may be turned into the ditch or the amount that may be by his ditch diverted from the stream. In case any owner or appropriator of public waters that have been adjudicated upon neglect or refuse to put in such measuring device, after thirty

days' notice to do so by the Territorial engineer, the said engineer may direct the water commissioner, of the district in which the ditch may be situate to put in such flume or measuring device, which being done by the water commissioner, he, the said commissioner, shall present the bill of the cost of such flume or measuring device to the owner or owners of the ditch, and if such owner or owners shall refuse or neglect, for three days after presentation of such bill, to pay the same, the said water commissioner may maintain a civil action in his own name, in any court of the Territory, for the recovery of the same, with all accruing costs. Said suit shall be prosecuted by the county and prosecuting attorney for the county wherein such suit may be brought, free of any charge against said commissioner.

SEC. 8. The Territorial engineer shall prepare and render to the governor yearly, and oftener if required, full and true reports of his work, touching all the matters and duties devolving upon him by virtue of his office, which report shall be delivered to the governor on or before the thirtieth day of November in each year, in order that the same may be laid before the legislative assembly at its regular sessions.

SEC. 9. In all cases in which the priorities to the right to the use of the waters of any of the streams of this Territory have have been adjudicated by any of the district courts of this Territory under the provisions of chapter two of title nineteen of the Revised Statutes of Wyoming, it shall be the duty of the clerk of the district court wherein such adjudication may have been made to forward a certified copy of such decree to the Territorial engineer immediately after the rendering of a decree in the matter of such adjudication, and for such copy there shall be paid to the said clerk, out of the treasury of the county wherein such decree was rendered, compensation at the rate of ten cents for each one hundred words contained in such decree. On receipt of such copy of such decree it shall be the duty of the Territorial engineer to cause the same to be recorded at length in a suitable book, to be provided for that purpose, and as soon thereafter as practicable to forward to the water commissioner of the water district wherein the stream adjudicated upon is situated a statement showing the title of the court in which such decree was rendered, the date of the decree, the name of each ditch the priority of which has been by such decree determined, its capacity, showing the width, depth, and grade of the said ditch and the quantity of water per second of time to which said ditch is declared by such decree to be entitled, to be expressed in cubic feet per second of time, and thereafter, in the supervision of the distribution of the waters of such streams by said ditches so adjudicated upon it shall be the duty of the said water commissioner to be guided by such statement. It shall be the duty of the Territorial engineer to procure and cause to be recorded in his office a description of the flume or other measuring device at the head of each ditch so adjudicated upon, showing the width, depth, and grade of each flume or other measuring device, and to calculate and determine the quantity of water, expressed in cubic feet per second of time, which will flow through such flume or other measuring devide at various depths, and furnish the proper water commissioner with a statement of the same.

SEC. 10. The water of every natural stream not heretofore appropriated, within the Territory of Wyoming, is hereby declared to be the property of the public, and the same is hereby dedicated to the use of the people of said Territory, subject to appropriation as hereinafter provided.

SEC. 11. Every person, company, or corporation hereafter constructing, enlarging, or extending any ditch, canal, or reservoir for irrigation or other beneficial purposes, and intending to use or appropriate any water from any natural stream within a water district for such purposes, shall, within ninety days after the commencement of the construction, enlargement, or extension of such ditch, canal, or reservoir, file and cause to be recorded in the office of the county clerk and ex-officio register of deeds of the county in which is situated the district court having jurisdiction of all questions concerning the priority of rights to the use of water in such water district, a statement of claim under oath, setting forth the name or names, together with the post-office address of the owner or owners of any such ditch, canal, or reservoir; the name thereof, if any, and if without a name, the owner or owners shall adopt a name to be therein stated, by which such ditch, canal, or reservoir shall thereafter be known; the number of the water district in which the same is situated; a description of such ditch, canal, or reservoir, as to location of head-gate and the general course of such ditch; the name of the natural stream from which such ditch, canal, or reservoir draws its supply of water; the length, width at top and bottom, depth, grade, and carrying capacity thereof, expressed in cubic feet per second of time, as near as may be; the time, giving the day, month, and year when work was commenced thereon by original construction, enlargement, or extension, as the case may be, and likewise the date when water was actualy appropriated therefrom for irrigation and other beneficial purposes; the number of acres lying under and being, or proposed to be, irrigated by water therefrom, and a map or plat on a scale of not less than one inch to the mile, showing the location or route of such ditch, canal, or reservoir, and the natural stream from which it draws its supply of water, and also the legal subdi-

visions of land through which they flow: *Provided*, That in case the said statement gives the direction or route of such ditch by courses and distances, according to the field-notes of the survey thereof, it shall not be necessary to include in any such statement the map or plat above referred to. Such statement shall be signed by the person owning such ditch, canal, or reservoir, or, in case of a copartnership, by any member thereof, for and in behalf of such copartnership, or in case of a corporation, by the president or secretary thereof, and such statement shall be recorded as aforesaid in a book to be kept for that purpose.

SEC. 12. If the owner or owners of any such ditch, canal, or reservoir shall prosecute the work of construction thereon diligently and continuously until completed, and shall otherwise comply with the provisions of law, such owner or owners shall, as regards the owner or owners of all other ditches subsequently constructed and drawing their supply of water from the same stream, have a priority of right to the use of such water from and after the date of the commencement of the construction thereof, but not otherwise. The beginning of all necessary surveys of such ditch shall be considered as the commencement of such work of construction.

SEC. 13. When the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purpose shall have preference over those claiming water for any other purpose, and those using the water for agricultural purposes shall have the preference over those using the same for manufacturing purposes.

SEC. 14. The priority of right to the use of such water shall be limited and restricted to so much thereof as may be necessarily used and appropriated for irrigation or other beneficial purposes as aforesaid, irrespective of the carrying capacity of the ditch, and all the balance of the water not so appropriated shall be allowed to run in the natural stream from which such ditch draws its supply of water, and shall not be considered as having been appropriated thereby; and in case the owner or owners of any such ditch, canal, or reservoir shall fail to use the water therefrom for irrigation or other beneficial purposes, or shall refuse to furnish any surplus water to the owner or owners of lands lying under such ditch as hereinafter provided, during any two successive years, they shall be considered as having abandoned the same, and shall forfeit all water rights, easements, and privileges appurtenant thereto, and the waters formerly appropriated by them may be again appropriated for irrigation and other beneficial purposes the same as if such ditch, canal, or reservoir had never been constructed; neither shall the owner or owners of any such ditch, canal, or reservoir have any right to receive from others any royalty for the use of the water carried thereby, but every such owner or owners having a surplus supply of water and furnishing the same to others from any ditch, canal, or reservoir as hereinafter provided, shall be considered common carriers and shall be subject to the same laws that govern common carriers.

SEC. 15. The owner or owners of any such ditch which carries a greater quantity of water than the owner or owners thereof necessarily use for irrigation and other beneficial purposes in connection with their own lands shall, when application is made to them for that purpose, furnish such surplus water at reasonable rates to the owners of lands lying under any such ditch for the purpose of reclaiming such lands and rendering the same productive, and in case of refusal so to do the owner or owners of any such ditch may be compelled by injunction suit to furnish such water on such terms as to the court may seem meet and proper: *Provided*, That the board of county commissioners in their respective counties shall have power, when application is made to them by either party interested, to establish reasonable maximum rates to be charged for the use of water, whether furnished by individuals or corporations.

SEC. 16. The cubic foot of water per second of time shall be the legal standard for the measurement of water in this Territory, both for determining the flow of water in natural streams and ditches and also for the purpose of distributing water therefrom.

SEC. 17. Nothing in this act contained shall in any wise interfere with any prior right to the use of said water; neither shall the owner or owners of any such ditch, canal, or reservoir who have heretofore complied with the laws relating thereto enacted by the ninth legislative assembly of Wyoming be required to file any additional statement of claim under the provisions of this act.

SEC. 18. Section thirteen hundred and forty-three of the Revised Statutes of Wyoming and all laws and parts of laws inconsistent herewith are hereby repealed.

SEC. 19. This act shall take effect and be in force from and after its passage

Approved March 8, 1888.

CONSTITUTIONAL PROVISIONS.

[FILED WITH THE COMMITTEE BY JOHN K. JEFFREY, SECRETARY OF STATE CONSTITUTIONAL CONVENTION.]

ARTICLE I.—*Declaration of rights.*

SEC. 31. Water being essential to industrial prosperity, of limited amount, and easy of diversion from its natural channels, its control must be in the State, which in providing for its use shall equally guard all the various interests involved.

SEC. 32. Private property shall not be taken for private use unless by consent of the owner, except for private ways of necessity, and for reservoirs, drains, flumes, or ditches on or across the lands of others for agricultural, mining, milling, domestic, or sanitary purposes, nor in any case without due compensation.

ARTICLE VIII.—*Irrigation and water rights.*

SECTION 1. The water of all natural streams, springs, lakes, or other collection of still water, within the boundaries of the State, are hereby declared to be the property of the State.

SEC. 2. There shall be constituted a board of control, to be composed of the State engineer and superintendents of the water divisions, which shall, under such regulations as may be prescribed by law, have the supervision of the waters of the State and of their appropriation, distribution, and diversion, and of the various officers connected therewith. Its decisions to be subject to review by the courts of the State.

SEC. 3. Priority of application for beneficial uses shall give the better right. No appropriation shall be denied except when such denial is demanded by the public interests.

SEC. 4. The legislature shall by law divide the State into four water divisions, and provide for the appointment of superintendents thereof.

SEC. 5. There shall be a State engineer, who shall be appointed by the governor of the State and confirmed by the senate; he shall hold his office for the term of six years, or until his successor shall have been appointed and shall have qualified. He shall be president of the board of control, and shall have general supervision of the waters of the State and of the officers connected with its distribution. No person shall be appointed to this position who has not such theoretical knowledge and such practical experience and skill as shall fit him for the position.

ARTICLE X.—*Corporations.*

SECTION 1. The legislature shall provide for the organization of corporations by general law. All laws relating to corporations may be altered, amended, or repealed by the legislature at any time when necessary for the public good and general welfare, and all corporations doing business in this State may as to such business be regulated, limited, or restrained by law not in conflict with the Constitution of the United States.

SEC. 2. All powers and franchises of corporations are derived from the people, and are granted by their agent, the government, for the public good and general welfare, and the right and duty of the State to control and regulate them for these purposes is hereby declared. The power, rights and privileges of any and all corporations may be forfeited by willful neglect or abuse thereof. The police power of the State is supreme over all corporations as well as individuals.

SEC. 3. All existing charters, franchises, special or exclusive privileges, under which an actual and bona fide organization shall not have taken place for the purpose for which formed and which shall not have been maintained in good faith to the time of the adoption of this constitution, shall thereafter have no validity.

FURTHER STATEMENT OF ENGINEER ELWOOD MEAD.

The CHAIRMAN. Do you wish to add anything to what you have already said?

Mr. MEAD. I wish to say that there is a condition of affairs that prevails here that your questions do not touch directly. I do not know whether it is peculiar to this territory or not, but I think it is important that it should be understood. The land laws at the present time make it difficult for the individuals who take the land to combine to make a ditch. A large expensive ditch takes a large amount of capital to build it, and a considerable length of time to complete its construction so that the people can get water from it. The settlers will starve to death before the ditch can be completed because they can not raise anything on the land while they are doing it.

The CHAIRMAN. That is not always the case. I have known instances where individuals, by combining together, have gone into gigantic enterprises.

Mr. MEAD. They can not do it here. I believe it is best for the settler and best for every one that these ditches should be built in advance of settlement. If we could by some mean secure the proper location for large canals, so that a few canals would distribute the water, we would get the water on better land, there would be a great saving in the water supply and it would be a manifest advantage to the people who came here to settle. I have seen many attempts by actual settlers to settle on these arid lands. They had to wait until the ditch was built. I have seen too much of the privation of their families to believe that that is a satisfactory method. If the ditch were built, so that a man could at once begin farming, there would be no suffering.

Senator JONES. What is your plan?

Mr. MEAD. I want to say first, what has been the development of this Territory, before I give the plan. We have found it impossible and unsatisfactory to combine under the present system of land owning. The result has been that people have combined and built a ditch to water merely their own claims. We have in this Territory to-day probably three thousand ditches built, though there are on record only two thousand five hundred and fifty. The great majority of those are individual ditches. Each settler who went on a stream built an individual ditch to water his own claim. Another settler came and did likewise. I can show you on the office maps twenty-six ditches on one stream in one township. The Territory is charged with a division of water between those several claimants. Take a stream 80 miles long and undertake to divide the water between eighty claimants, and you will understand the difficulty. That plan is immensely wasteful of water and of everything. It is very difficult to maintain those ditches. The average expense of watering land by that system is over $10 an acre. If we could have highland channels that would water those areas, it should not cost half that much to get the water on the land, and more water would get on it. My idea is to turn this land over to the Territory or to the local government, under such regulations as will secure its final disposal to actual settlers, and the Territory could put the companies under such restrictions as would secure ditches, and could also manage the work of their being settled by actual settlers. We would then have a system that could be intelligently planned,

The CHAIRMAN. Do you know of any State or Territory that has managed its lands well that has adopted that plan?

Mr. MEAD. Yes, I think that on the whole the management of the land by Colorado has been fully as wise as the management of the land by the Government.

Senator JONES. Would you advise the Government to authorize the States to make any other disposition of those lands except by homestead settlements?

Mr. MEAD. This would be my plan: to turn these lands over to the States. The proper procedure would then be, either for the State or the National Government, to locate these canals on the streams, say where they ought to be. Then it can make a close estimate as to the cost of construction and what it would cost to operate the same. I would then allow private capital to build that ditch, and would permit the companies to charge (to have an agreement in the first place that they might charge) a fair rental for the water and I would provide for that to be continued subsequently, if necessary. Then in regard to the land, I would do this: I would permit the ditch companies, perhaps, to have the management of the settlement. I would make them colonization agents but I would have the State itself pass the title to the settler. I would not make any title absolute until I knew that it was a bona fide settlement; but I would put the settlement of it in the hands of the ditch companies. They will have the greatest interest in securing settlement. What the ditch company needs is an assurance that the land will be settled when the water is there. They want to be in a position, so as soon as the ditch is built, to run it the next year to its full capacity. If they can do that they can furnish water at a much less rental.

Senator JONES. That is true; but get back to the main question. Would you authorize or advise the National Government to convey this land to the State for any purpose except to be used for homesteads?

Mr. MEAD. No; nothing else.

The CHAIRMAN. Then the State would get nothing on earth by the conveyance from the Government to the State, because the land is now within the State, and it is already subject to homestead settlement.

Mr. MEAD. I do not understand your question. Do you mean that you would not permit the State to derive any revenue whatever from this land?

Senator JONES. I want to know whether you would allow the State to mortgage the land to the ditch companies for instance?

Mr. MEAD. I would not allow the Government to transfer to the State only under the condition that it was to be disposed of to an actual settler and cultivator; but I would permit the State to charge for it and sell it.

Senator JONES. Then your idea is to turn the land over to the States to enable them to create a fund to build the ditches?

Mr. MEAD. To create a fund to manage, and if necessary to create a fund to build, the ditches. I state in my report that I do not think reservoirs can be built unless conditions change. If they are built they must be subsidized.

The CHAIRMAN. They are building them in some places.

Mr. MEAD. That is my judgment in regard to this Territory. There are but few favored places where they will be built, but I have in view a comprehensive system. The places where reservoirs can be built as a business proposition are restricted.

The CHAIRMAN. You speak of selling the water. Do you think it

will be advantageous to have the water owned and controlled by corporations?

Mr. MEAD. No; the water would not be owned at all. It would be a common carrier that had built the ditch and that carrier could only make a charge for transportation.

Senator JONES. Suppose it did not result as you anticipate it would, what would happen?

Mr. MEAD. In what way do you mean?

Senator JONES. How is the ditch company to get its money? Suppose this State makes a contract for a company to go out into one of the valleys and expend a million dollars to bring water on the land; that money is expended, and suppose the place did not settle up, then what?

Mr. MEAD. The company would lose. But the difficulty at the present time is that the ditch companies have no control over settlement.

Senator JONES. And they ought not to have.

Mr. MEAD. I should not want the ditch companies to have it in their power to prevent settlement, but I would wish them to assist settlement.

Senator JONES. I am something of a crank on the idea that the remaining lands of the United States should be made into homes.

Mr. MEAD. That is right.

The CHAIRMAN. How would you regulate the price of water?

Mr. MEAD. Land upon which there is no ditch in this Territory will have a price varying from 15 cents to $1.50 per acre—I mean grazing lands. If you construct a ditch over such land, say a large ditch, so as to make it certain that there will be a considerable settlement there, that land is ultimately reclaimed, and the result will be that the land will enhance in value from the construction of that ditch from $5 to $15 per acre. Suppose a ditch company goes in at the present time to build that ditch and make it possible for the pre-emptor or homesteader or any one with a timber claim to go and file on the land, settle down, and get a title to the land, without in any way contributing to that enterprise of the ditch company, it makes it possible for him to reap that unearned increment.

Senator JONES. But he does not get any value from the ditch.

Mr. MEAD. Suppose a man files on the pre-emption claim and lives on it six months; if that land enhances in value he can sell it. Now, does he not reap the benefit?

Senator JONES. Not a bit. He has to get the water. The possibility of getting the water is one thing, but when he gets the water he has to pay for it. The water may be there and, when he buys the ditch, he figures that up in connection with the possibility of getting the water. But the truth is there is not any value in any of this land. The value is in the water.

Mr. MEAD. Exactly; and we want a system that will distribute that water to the best advantage and save it.

Senator JONES. There is no doubt that there ought to be some changes made.

REPORT SUBMITTED BY ELWOOD MEAD, TERRITORIAL ENGINEER.

IRRIGATION IN WYOMING.

No.-I.

1.—Water Supply.

The mountains are the great condensers of moisture and the conservators of our summer water supply. The more extensive and elevated these are the more abundant and long-continued the summer discharge. The extent of the mountain area is therefore as important as that of the plain in estimating the ultimate extension of our irrigated area.

The mountains contributing to the water supply of this Territory are the main range of the Rockies in Colorado and southern Wyoming, the Big Horn and Wind River Mountains in the north, and the mountains of Uinta County in the west. In addition there are the minor ranges, including the Sweetwater and Rattlesnake Mountains in the central portion, the Laramie Range in the east, and the Black Hills Range in the northeast. Taken as a whole, the mountains which form the culmination of the water-sheds of our streams are equal in area to fully one-third of the Territory, or about 35,000 square miles, or 22,400,000 acres.

It is difficult to arrive at a satisfactory conclusion as to the amount of precipitation which falls on these mountains owing to no regular observations having been kept. That it is unusually heavy is known. The reports of the explorations of the Yellowstone Park region state that the snow-fall of that section is above the average for the Rocky Mountains. From this and other data I am led to believe that the rain and melted snow must cover these mountain summits to an average depth of between 2 and 3 feet, giving approximately 60,000,000 acre-feet of water deposited each year. If we suppose that two-thirds of this disappears by evaporation and in other ways there still remains 20,000,000 acre-feet passing down the streams and available for irrigation. Taking the average duty of water at 1 cubic foot per second for 80 acres, this is sufficient water to serve 10,000,000 acres, and it only requires the utilization of the resources here to see our agricultural area extended to this limit.

2.—Location and Distribution.

The location of these mountain areas is such as to cause the Territory to be exceptionally well watered. The streams flow down from their slopes in every direction and penetrate all portions. Although there are over four hundred streams from which water is diverted for irrigation, they form themselves into four natural divisions or drainage systems. These divisions, although differing from the water districts defined by law, will, for convenience, be used in this statement, being designated as 1, 2, 3, and 4.

Of these, the Platte River and its tributaries form the first, the North Platte being the principal stream, and is one of the most important leaving the eastern slope of the Rockies. Having its source on the western slope of Long's Peak, in Colorado, it drains an extensive mountain area before entering this Territory. Owing to its detour to the north it waters a large district within our borders; its length from the Colorado to the Nebraska border being about 350 miles. Of this distance there is probably no section 50 miles in length where its waters can not be diverted, but owing to the expense involved in constructing the necessary head works to withstand the floods of a stream of such volume the principal development has occurred on its tributaries. Maps showing the ditches on three of these streams, the Laramie River, Horse and Crow Creeks, accompany this statement.

Division No. 2 comprises all the streams east of the Big Horn Mountains. In this division irrigation has attained its greatest success and importance, the counties of Johnson and Sheridan having a fine water supply from the streams flowing from the Big Horn Mountains. The rapid fall of this region to the east and north offers unusual facilities for diverting water; a peculiar feature in this section being the large number of canals carrying water across the divides from the stream into the valley of another. The stability of the water supply and the enormous fall which can be readily obtained marks this as a suitable location for the development of extensive water-powers when the country is made accessible by railroads. As yet the development has been restricted by the lack of capital to undertake the construction of large canals to rent water, but there are fine opportunities throughout this region for such enterprises. The main reason for the delay in their inauguration being stated in my main report.

The third division includes the Big Horn River and its tributaries. It is one of the best watered portions of the arid region, as it drains both the Wind River and Big Horn Mountains. Owing to the enormous discharge of these streams, and the fact that the uplands can only be watered by costly works, the settlers have had thus far but little apprehension of any scarcity in the supply, and have consequently been negligent in recording their ditches. Hence the statement of the ditches diverting water from the streams of this division, given further on, is much below the truth.

The Green, Bear, and Snake rivers are the tributaries from the fourth division. Considerable work has been done on Bear River and a few of the tributaries of Green and Snake Rivers, but this division as a whole, like number 3, is practically untouched as compared to the possibilities here presented. The large surplus of water here has operated, as in division 3, to make ditch owners neglect to record their claims. The records of Sweetwater County being so manifestly below the truth, I have omitted all statistics from that county.

The valleys of the Green and Big Horn offer to-day the best opportunities for the construction of a system of irrigation works, according to a pre-arranged plan, of any section with which I am familiar. To a large water supply and immense tracts of valuable public land there is added the total absence of vested rights to interfere with the construction of the necessary works. It is to be hoped that suitable measures may be taken for the designing and construction of such system of works. It would prove a valuable object-lesson when placed in contrast with some of our former efforts.

No attempt has been made to estimate the extent of irrigation possible in each section, since the absence of stream gaugings gives no data on which to base one.

3.—Irrigation Works.

Under the Territorial laws the owners of the ditches are required to file, in the offices of the county clerks of the various counties a statement showing their capacity, location, acreage watered, and such additional facts as are required to make a complete record. As there is no penalty attached to a failure to comply with this requirement many ditches are not recorded, probably five hundred in the whole Territory, and, owing to defective blanks used at first many that are recorded have made incomplete statements, so that it is impossible to state accurately the area reclaimed. Below is given a table giving the present extent of our irrigation development as shown by the recorded statements, the majority of which have been verified by engineer's certificate as to the dimensions and capacity. It is an extraordinary record when it is remembered that it is principally the work of the past ten years. In extent the irrigated area exceeds the average of the land farmed in each of the New England States, and should forever put at rest the cavil or question as to the ultimate wealth and greatness of this commonwealth. If the pioneers in this work can, unaided and under great disadvantages, produce such results, what may not be accomplished through the intervention of ample capital or of State or national aid?

4.—Expenses of Reclaiming Land.

Some time since there was issued from this office a letter of inquiry to ascertain the cost of reclaiming the arid lands. These inquiries were addressed to farmers of known intelligence and of considerable practical experience. The replies are of great value in throwing light on this subject, and I have had them arranged and copied, and they are herewith submitted as Appendix B.

Representing the views of all sections of the Territory, and based on actual experience their statements are entitled to a careful consideration, especially as to some of the perplexing questions which now confront us. While the views as to the proper course to be adopted are somewhat at variance there is a unanimity of sentiment as to the desirability of a more liberal policy in respect to the disposal of the public land. Their statements are also valuable in indicating the amount of money which has been expended in reclaiming the land already under ditches. The amount varies in the different statements from $5 to $25 per acre, so that $10 would be a low average, making the total expenditure for this work over $15,000,000.

5.—Territorial Supervision.

The irrigation laws of this Territory are very largely copied from those of Colorado, but are in some respects in advance of the parent legislation.

The control of the water by the State is affirmed, and ditches are by law made common carriers. Priority of use gives the better right, and provision is made for settling disputed cases in the courts.

The engineer is the chief executive officer of the system and is charged with the "supervision of the diversion and distribution of the public waters, and of the offi-

cials connected therewith." The Territory is divided into nine water districts, in each of which a water commissioner controls the diversion of the water. The important defect of the system is the failure to exercise any control over the streams prior to construction of ditches, and to take steps to secure the proper location and construction of distributing works. The constitutional convention now in session has, however, provided a remedy for this when we become a State.

6.—Future Development.

The problems to be solved in connection with this subject are the obtaining of means for the construction of canals of too great magnitude and expense for combinations of farmers to attempt, and the improvement and utilization of storage reservoirs to hold the waste water of winter and the surplus from the summer floods. There are great possibilities in either direction. On all the important streams there are splendid opportunities for the construction of extensive works to water the uplands, and an abundance of water to supply them when built. With the building of these will come an era of growth and prosperity to our agriculture of which we can scarcely form a conception at the present time. These canals can and will under proper conditions be built by individual or co-operative enterprise, but I am persuaded that if any extensive system of reservoirs are to be brought into use it must be under different auspices.

On many of our streams is already felt the pressing need for an auxiliary summer's supply which the reservoir would furnish, but the expense of improving and making available these storage basins prevents the work being undertaken as a business enterprise. The value of the land and of the products grown thereon will only justify a certain outlay for water, and this, with us, must always be less than in the semi-tropical portions of the country where the higher priced products will warrant a far greater outlay.

There are sites for such storage basins on nearly every stream and there would come an immense extension of cultivated area from their improvement. The chief beneficiary of such extension is the State and nation, since it results in an increase of the productive capacity of the country and makes a perpetual addition to the public revenue. I believe that the benefits to be derived therefrom will amply warrant and justify the giving of aid in this work by the National Government, and in fact renders this course the only sound public policy.

Should such aid be extended, it will result in such an irrigation development here as will, with the exception of Snake River, prevent the passage of any unutilized water beyond the borders of the Territory.

Summary of irrigation development by districts.

District.	Total No. of recorded ditches.	Total length as stated.	No. of claims, with statement of length omitted.	Total capacity as given.	No. of ditch claims, omitting statement of capacity.	Total acreage watered as given.	No. of ditch claims, omitting statement of acreage.
1*	643	1,322.385	39	5,911.584	48	482,434.00	89
2	327	582.793	31	6,649.844	53	379,164.64	63
3	282	317.419	91	3,644.078	72	395,563.00	114
4†							
5	502	996.398	32	10,422.70	57	440,540.00	50
6	124	196.955	46	1,556.325	36	58,162.00	55
7	322	518.24	50	1,658.905	96	108,976.78	95
8	182	212.41	52	3,095.487	79	35,395.00	96
9	49	91.43	1	342.00	25	42,460.00	3
‡	7	11.905		136.8		4.180.00	
Total..	2,438	4,249.935	242	20,381.723	466	1,946,875.42	561

* Seven reservoirs additional.
† District No. 4 omitted because of incomplete record.
‡ Unorganized district.

Ditch record, water district No. 1.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Alkali Creek	2	.933	10.8	1,760			
Antelope Creek	2	2.35	6.5	320			
Alum Creek	1	1.5	50.	100			
Badger Creek	1	1.5				1	1
Bear Creek	40	53.282	374.27	11,480	3	2	10
Bear Creek, south fork	2	26.6	16.2	10,220			
Beaver Creek	1	1	6.	80			
Blue Grass Creek	1	2.5	16.77	800			
Box Elder Creek	3	3.281	9.1	3,360			
Big Springs	2	2.	6.66	360			
Cabin Creek	5	1.75	26.27				5
Canon Creek	5	4.314	23.14	1,420			
Cherry Creek	2	11.5	19.2	8,320			
Cheyenne River	8	36.4	29.35	21,220			
Chugwater Creek	40	98.25	529.87	20,405	1	2	3
Clear Creek	11	8.5	18.11	2,520			
Corn Creek	2	2.2	3.44				2
Cottonwood Creek	5	4.3	25.56	1,280	2	2	1
Crow Creek	38	96.35	377.02	38,486		1	3
Deadhead Creek	2	1.95	3.91				2
Dry Creek	8	15.75	66.35	370			6
Davis Springs	1	1.	.756	200			
Donkey Creek	1	2.	9.	320			
Dry Laramie Creek	1	4.	7.17				1
Duck Creek	10	12.625	44.625	3,680			
East Beaver Creek	4	18.5	59.11	3,900			1
Fish Creek	4				4	4	4
Four Mile Creek	3	4.96	13.8	1,840	1	1	
Fox Creek	4	23.7	21.	12,995			
Goose Creek	8	7.60	44.32	3,800			
Hay Creek	2	3.6	33.3	1,920			
Hanson Creek	1	1	35.	200			
Horrick Creek	2	1.75	10.8	250			
Horse Creek	58	227.525	1,041.23	109,658	2	1	2
Horseshoe Creek	10	23.	74.3	12,675			
Lance Creek	2	8.25	77.4	1,400			
Laramie Creek	7	21.	152.78	4,280			
Little Bear Creek	16	13.75	21.8	2,405	7	7	7
Little Horse Creek	6	10.25	92.56	5,670			
Lodge Pole Creek	18	71.575	243.86	30,910			1
Lone Tree Creek	38	51.175	190.95	13,620			
Maginnis Creek	1	.75	1.62	160			
Main Beaver Creek	2	18.1	10.8	5,850			
Marble Creek	1	.625	5.5	20			
Maxwell Creek	9	4	34.9	720			
Middle Crow Creek	15	14.528	221.89	2,660	2	1	5
Middle Lodge Pole Creek	1	1.	4.92	160			
Mills Creek	7	12.	44.43	1,985			
Mountain Lion Creek	4	3.1	11.2	1,200			
Muddy Creek	8	10.25	32.35	1,170			
Mule Creek	4	3.75	19.3				4
Muskrat Creek	1	1.5	2.08	160			
McShane Springs	4	3.	*14.2	640	2	2	2
North Bear Creek	2	4.	6.84	550			
North Chugwater Creek	9	5.679	48.81	1,685			
North Crow Creek	9	15.5	95.5	2,000			
North Horse Creek	9	25.25	67.1	3,105			
North Laramie River	4	9.5	84.86	3,100	1	1	1
North Old Ditch Ranch Springs	2				2	2	2
North Platte River	5	32.	248.5	23,280	1	2	1
North Pole Creek	10	17.611	50.67	2,270			
North Reshan Creek	2	1.75	13.92	200			
North Richard Creek	1	2.5	4.2				1
North Spring Creek	1	.75	(†)	160		1	
Oil Creek	3	13.5	139.4	8,720			
Old Woman Creek	1				1	1	1
Pappoose Creek	1	.75	4.5	160			
Pine Bluff Creek	1	1.25	.14	360			
Pole Creek	1	.75	5.26	160			
Plum Springs	1	1.	.256	160			

* Also two reservoirs containing 7,128,000 cubic feet.

† 360 square inches.

Ditch record, water district No. 1—Continued.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Porter Creek	2	1.	6.	140			
Rawhide Creek	10	25.833	92.68	7,240			
Reshaw Creek	2	2.25	27.61	70			
Richard Creek	14	30.175	115.49	9,660			
Running Water Creek	7	8.	24.3	1,480	2	2	2
Sage Creek	3	6.05	12.9	640			1
Sand Creek	3	2.375	6.38				2
Seven Mile Creek	1	.75	3.2	360			
Scratch Creek	4	2.25	12.				4
Skull Creek	5	10.	47.1	3,140			
South Crow Creek	16	24.25	102.14	6,790	1	3	1
South Horse Creek	6	4.75	15.30	926			
South Fork Fish Creek	2				2	2	2
South Chugwater Creek	12	19.25	148.25	1,825			1
South Branch South Chugwater Creek	1	5.125	1.33	35			
South Pole Creek	6	14.	43.69	2,204			
South Sundance	2	.75	13.1	200			
South Spring Creek	1	1.25	(*)	160		1	
Summit Spring	1	5.				1	1
Springs (Dyer)	1	.25	.02	40			
Springs (not named)	2	2.	3.	360			
Spring Creek	25	18.781	109.757	2,855	5	6	7
Spring Branch Creek	5	3.	30.1	1,310			
Spotwood Creek	1	2.	2.4	400			
Stockade Beaver	8	22.95	60.8	10,920			
Three Mile Creek	5	10.	†16.58	870		1	
Upper Richards Creek	2	.933	4	120			
Van Tassel Creek	3	2.25	37.32	600			
Willard Creek	1	1.5				1	1
Wyatt Creek	1	2.	4.57	280			
Total	643	1,322.385	5,911.584	482,434	39	48	60

* 360 square inches. † Also 100 square inches.

Ditch record, water district No. 2.

Alkali Creek	1	.75	20.	140			
Antelope Creek	7	5.2	49.922	1,240	2		
Barbour Creek	1	1.33	25.5	1,200			
Bear Creek	1	1.25	39.5	100			
Big Laramie River	37	136.64	1,899.644	166,830	3	3	3
Blue Grass Creek	1	2.5	16.77	800			
Body of Springs	1	.5	1.22				1
Boneder Creek	1	.75	3.	160			
Box Elder Creek	5	13.85	163.33	6,070			
Branch of Box Elder Creek	1	.5	2.93	60			
Brown Creek	4	9.75	47.	3,800	1	1	2
Cabin Creek	1	.4	36.7	1,000			
Camp Creek	1	.33				1	1
Cañon Creek	2	.875	16.	100			
Carroll Creek	1	2.5	23.46	680			
Claude Creek	1	1.	3.59	500			
Clear Spring Creek	1	.5	4.67	60			
Cooper Creek	4	1.2	34.18	3,200			
Deep Gulch	1	.25	1.	50			
Deer Creek	2	4.06	70.81	1,200			
Duck Creek	6	3.58	13.11	470	1	2	
Dutton Creek	4	11.75	82.9	2,600			
Dry Creek	1	6.	68.16	3,200			
Dry Muddy Creek	2	4.4	81.	1,000			
Fish Creek	8	10.	18.87	1,290	4	4	4
Five Mile Creek	5	8.1	228.1	1,560			
Four Mile Creek	4	3.35	24.	1,280			
Fox Creek	3	12.	126.84	4,500			
Garden Creek	8	8.18	302.7	6,000			
Goose Egg Creek	1	1.75	8.07	240			
Grant Creek	2	.819	4.	90			
Harney Creek	4	4.5	56.3	1,900	1	1	1

Ditch record, water district No. 2—Continued.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Hay Creek	1	1.25	1.02	50	..		
Indian Creek	2	1.		180	..	2	
Knight Creek	3	1.75	8.	214			
La Bank Creek	7	15.5	100.	1,800	2	4	6
La Prelle Creek	12	11.125	45.37	2,900	8	10	10
Little Box Elder Creek	3	2.35	33.	320	1	1	2
Little Laramie River	48	76.415	700.918	45,825	1	4	4
Meadow Creek	1	.75				1	1
Mill Creek	17	19.975	285.58	6,215	..		1
Middle Fork Chug Water	1	2.5	2.	160			
Mountain Creek	2	.5	5.	200	1	1	1
Muddy Creek	4	1.9	58.	2,000	3	3	3
Muddy Wagon Hound Creek	1	1.	10.	640			
Mule Creek	2	1.25	13.32	1,038.64	..	..	
North Bed Leek	1	.25	1.		..	..	1
North Fork Little Laramie River	4	7.2	42.49	2,400	..		
North Laramie River	1	15.	124.	10,000			
Northwest Branch Fox Creek	1	1.	2.5	160	..		
Pine Gulch Creek	2	1.75	3.3	300		1	
Plumbago Creek	2	2.5	3.28	640		1	1
Poison Spider Creek	1	2.	12.	1,000			
Red Mountain Creek	2	4.				2	2
Sand Creek	4	7.55	104.41	5,050			
Seven Mile Creek	6	5.524	53.81	2,920		1	
Sheep Creek	2	.33			1	2	2
Shell Creek	1	1.	22.38	1,200	..		
Slate Creek	5	2.08	8.8	300	..	..	
Soldier Creek	3	3.6	45.78	320	..		2
South Sybille Creek	3	2.75	10.61	347	..	..	
Spring	3	1.17	3.5	217			
Spring Creek	5	5.415	18.26	720		2	3
Steamboat Lake	1	2.	8.	400	..	..	
Sward Creek	3	2.5	28.60			..	3
Sybille Creek	21	81.55	1,124.83	71,130	2	5	8
Three Mile Creek	4	1.28	17.	520		..	
Trail Creek	1	1.		140		1	
Wagon Hound Creek	5	10.	99.78	3,040			
Ward's Gulch Creek	5	12.125	52.92	4,220	..		..
Weber Mills Creek	3	2.55	23.	860	..		
Willow Creek	12	10.82	74.01	2,300	..		
Total	327	582.793	6,649.844	379,164.64	31	53	62

Ditch record, water district No. 3.

Austin Creek	2	2.25	80.66	520			
Alemoose Creek	1	1.25		160		1	
Badger Creek	1				1	1	1
Bangs Creek	1	.5	5.	160	..		
Bates Creek	4	8.776	74.18	3,010	..		
Battle Creek	1	.75	25.				1
Bear Creek	2		7.5		2	1	2
Beaver Creek	7	3.	89.79	825	4	2	4
Big Creek	3	4.784	198.42	4,900	1	..	1
Big Creek, South Fork	1	.25	7.88	40	..		
Brush Creek	8	10.5	135.3	6,960	4	3	2
Brush Creek, North Fork	1				1	1	1
Bush Creek	1				1	1	1
Big Bear Creek	2	1.5	45.	200	1	1	1
Big Squaw Creek	1	.5	6.		..	..	1
Calf Creek	1	1.	2.82	400	..		
Carbon Creek	1	.5	2.5	160	..		
Carp Creek	1	1.			..		
Cedar Creek	6	5.	55.	570	3	2	3
Centennial Creek	1				1	1	1
Charley Catlin's Creek	1		14.4		1		1
Cherokee Creek	1				1	1	1
Cherry Creek	1	1.25	3.24	200			
Claude and Elkhorn	1				1	1	1
Cole Gulch	1	.5	12.5	160			

Ditch record, water district No. 3—Continued.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Cole Springs	1	.....	.....	.....	1	1	1
Carroll Creek	2	1.324	11.99	320			
Cotton Creek	1	.....	.174	.....	1	.....	1
Cottonwood Creek	3	.416	2.5	.....	3	2	3
Cow Creek	6	6.881	29.835	985	2	..	2
Difficulty Creek	1	2.	8.64	200	..	..	
Dolvus Spring	1	.75	2.	160	.	...	
Dry Creek	4	4.5	64.64	938	2	1	2
Dutch Joe Creek	1	.....	.....	.....	1	1	1
Dutton Creek	5	3.293	56.	300	....	..	3
East Elkhorn Creek	2	3.	30.	.....	...	...	
East Qualey Creek	1	.4	4.	320	.	.....	...
Elkhorn Creek	3	5.5	43.55	1,240	..	..	1
Eureka Creek	1	.625	4.5	880	..	.	.
Field House Creek	1	1.25	4.74	320	...	...	
Fish Creek	1	.5	3.	100	....	.	..
Foot Creek	4	4.	28.847	2,080	1	1	1
Fort Hallock Creek	7	.....	105.573	... .	7	2	7
Grand Encampment River	7	12.	80.832	2,300	4	1	4
Goshart Creek	1	.....	.....	.....	1	1	1
Hat Creek	2	2.	19.47	830	.	..	
Horse Creek	2	1.5	9.2	300	.	..	..
Hurt Creek	5	....	33.5	.....	5	...	5
Jack Creek	5	11.25	7.5	200	..	3	3
Johnson Creek	2	2.	6.48	040	1	1	1
Joe Creek	1	.31	.....	.....	..	1	1
Kinney Creek	1	2.75	5.4	1,000	..	....	..
Lederhind Creek	1	.75	1.65	500	....	...	....
Lake Creek	3	3.25	76.62	940	...	...	....
Lake Creek (Smith Fork)	2	2.25	3.	200	...	...	....
Little Bear Creek	3	1.	19.08	240	1	1	1
Little Beaver Creek	5	.5	16.41	320	4	2	4
Little Medicine Bow	1	6.	45.1	3,000	....	....	..
Little Red Creek	1	.....	.....	.	1	1	1
Little Sand Creek	2	1.36	5.83	300	1	1	1
Little Squaw Creek	1	.66	4.	240	...	...	.
Loomis Creek	1	.75	1.25	80	....	...	..
Medicine Bow River	7	12.34	84.2	1,360	1	3	4
Mike Hanley Creek	2	.25	1.5	160	1	1	1
Milk Creek	2	2.76	(*)	520	...	...	..
Mill Creek	2	1.	7.5	160	1	1	1
Muddy Creek	8	5.48	70.6	1,110	3	3	5
North Platte River	14	25.01	596.54	8,095	5	4	6
North Spring Creek	7	7.5	68.43	1,930	1	...	2
North Spur Creek	1	3.875	7.	760	..	...	....
North W L Creek	4	2.95	12.95	540	...	..	....
Otto Creek	1	2.	1.	[redacted]	....	...	....
Overland Creek	1	3.5	26.	500	....	...	....
Park Creek	1	.....	.2	.....	1	....	1
Pass Creek	17	28.5	343.56	16,793	5	5	5
Pete Creek	4	3.5	21.075	600	..	....	....
Pine Grove Creek	5	1.75	3.61	160	3	3	3
Rattlesnake Creek	1	1.4	11.9	200	..	...	....
Roaring Creek	1	1.5	9.05	320	....	....	...
Rock Creek	1	1.5	26.	500	...	....	....
Sage Creek	4	1.27	7.6	65	2	2	3
Sage Creek (South Fork)	1	.....	.....	.....	1	1	1
Sand Creek	2	3.44	52.32	1,050	....	....	....
Savery Creek	5	6.56	53.	760	....	1	3
Separation Creek	4	2.405	36.79	740	1	1	1
Snake River	12	19.53	353.91	7,900	3	3	3
South Spring Creek	3	14.	122.332	3,500	....	...	..
Snow Shoe Cañon	1	.....	.....	.....	1	1	1
Spencer Creek	1	.....	.....	.....	1	1	1
Spring Creek	1	2.	.86	400	....	....	...
Sullivan Creek	5	7.4	36.1	1,000	....	....	....
Supply Creek	2	.63	9.95	150	....	....	1
Supply Lake	1	1.2	7.37	240	....	....	....
Sweetwater River	3	13.25	22.26	6,440	....	1	....
Thode Creek	1	1	.....	80	....	1	....
Three Mile Creek	2	3.5	24.24	835	...	....	....

* Also two reservoirs containing 7,128,000 cubic feet.

Ditch record, water district No. 4—Continued.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length.	No. of ditches omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Trent Creek	1	1.		200		1	
Troublesome Creek	5	1.89	39.75	250	2	2	2
W. L. Creek	1	1.5	4.25	250			
Upper Creek	1	.17				1	1
Wagon Hound Creek	4	3.79	67.1	1,200		1	1
Willow Creek	1		15.		1		1
Total	262	317.419	3,644.078	395,563	91	72	114

Ditch record, water district No. 5.

Alkali Creek	4	3.3	7.13	760		2	
Amedem Creek	3	4.75		300		3	3
Ashworth Creek	1	2.	12.	160			
Bear Gulch	1	1.5	3.	320			
Beaver Creek	11	23.61	177.07	3,985	1	1	1
Beek's Ditch	1	3.75	17	240			
Big Goose Creek	18	35.78	252.79	12,795	2	6	5
Big Horn River	1	18.5	220.	16,000			
Big Rapid Creek	4	9.	58.22	980			
Big Piney Creek	2	2.25	17.30	320			
Billy Creek	2	1.5	18.75	260			
Blue Creek	2	2.6	81.2	910			
Box Elder Creek	3	3.75	29.23	380	1		
Broken Back Creek	2	4.99	49.	680			
Buffalo Creek	3	28.6	236.92	5,540			
Buffalo Springs	1	.1	5.1	40			
Buffalo Flat Creek	1	1.	2.	160			
Bumdage Creek	1			400	1	1	
Cat Creek	1	2.				1	1
Cane Creek	2	1.	9.5	200			
Chake Cherry Gulch	3	1.25		80		3	
Clear Creek	26	93.66	765.59	31,250	1	1	3
Coal Creek	2	9.5	26.	3,280		1	
Columbus Creek	4	11.75	80.	2,500		2	
Coon Creek	1	.75	3.	80			
Cottonwood Creek	2	3.	57.	2,620			
Crazy Woman Creek	4	10.75	155.	4,100	1		1
Crooked Creek	3	2.95	84.84	3,500			
Cross Creek	1	3.75	20.				1
Davis Creek	5	2.25	14.04	475			
Day Creek	3	4.75	9.83	600		1	2
Dutch Creek	5	10.1	131.8	1,040	1	1	2
East Pass Creek	1	6.375	68.2	45,000			
East Branch Dutch Creek	1				1	1	1
Eureka Creek	1	.6	4.5	880			
Five Mile Creek	3	7	2.5	720			
Five Springs Creek	3	5.31	76.				3
Four Bear Gulch	1	1.37	1.25	320			
Flume Gulch	1				1	1	1
Franks Forks Creek	2	6.37	46.6	1,800			
French Creek	13	20.95	243.41	10,605			
Goose Creek	1	4.	38.	1,200			
Gooseberry Creek	1	.568	6.	80			
Grass Creek	1	1.3	25.	100			
Grey Bull River	12	23.29	201.2	8,600	1	2	3
Hanna Creek	2	2.75	5.	320		1	
Hurlbut Creek	3	4.25	6.31	740			
Herb Creek	1	2.5		500		1	
Herford Creek	1	.2	3	180			
Hewes Creek	2		24.06	140	2		
Horse Creek	2	1.	3.5	100			
J. A. Creek	3	1.52	16.85	220			
Jackson Creek	1	.125	15.	200			
Johnson Creek	5	8.95	52.31	1,860			
Kelly Creek	8	7.5	40.55	1,600			
Kruse Creek	4	4.5	8.53	1,340			
Large Spring	1	.5	4.5	20			

Ditch record, water district No. 5—Continued.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Little Horn (branch of)	1	5.5		1,500		1	
Little Canyon Creek	2	6.	32.	800			
Lake Creek	1	2.5	20.	1,200			
Little Fork, Left Branch Dutch Creek	1	1.5	6.	160			
Little Goose Creek	13	67.2	434.38	20,975		1	2
Little Muddy Creek	1	.2	4.	180			
Little North Fork Crazy Woman	1	6.75	26.5	1,500			
Little South Fork Crazy Woman	1	.6	2.15	75			
Little Piney Creek	6	7.25	78.4	1,140	2		1
Little Rapid Creek	1	1.	2.	160			
McKee Gulch	1	.5				1	1
Mead Creek	4	3.	26.77	460			
Medicine Lodge	1	3.6	14.	360			
Meteetse Creek	6	7.16	63.5	960	1	1	1
Middle Fork Crazy Woman	8	15.85	327.24	11,180	3	2	1
Middle Fork Powder River	2	2.4	49.	2,000			
Mill Creek	1	.1	36.39				1
Muddy Creek	6	8.1	90.1	2,240			
Murphy Creek	1	1.	5.	60			
National Springs	4	2.465	45.22	1,180			
No Wood	2	1.75	36.	240			
North Fork Twin Creek	1	.5		100		1	
North Fork Piney Creek	3	1.25	525.9	15,125	2		1
North Fork Powder River	3	3.9	52.83	2,600			
North Fork Crazy Woman	8	19.1	406.55	31,100			
North Fork Clear Creek	3	8.5	201.2	8,700			
North Fork Pass Creek	3	1.5	9.5	400	1	1	1
North Fork Rock Creek	3	2.205	16.58	620			
North Fork Broken Back	1	1.	3.	160			
Owl Creek	7	8.	95.6	3,860			
Paint Rock Creek	6	11.06	168.1	2,120			
Pakee Flat Springs	1	1.6	14.1	800			
Park Creek	4	3.46	34.	660			
Papypo Creek	1	.6	15.33	120			
Parker Creek	1	.6	17.15	600			
Pass Creek	1	1.5	18.	1,000			
Puckett Creek	1	.3	11.	80			
Piney Creek	18	56.05	849.35	35,105			
Pole Creek	2	1.5	8.	295			
Powder River	3	14.5	141.9	4,300			
Prairie Dog Creek	6	11	60.46	2,030	1	1	1
Rapid Creek	6	10.45	54.33	1,630		1	1
Red Cañon	1	1.5	4.	100			
Rock Creek	29	69.115	883.2	42,290	1	2	3
Sage Creek	3	5.5	31.6	1,500		1	
Sagles Creek	8	7.625	70.02	1,445			
Say Ho Creek	1	.4	18.2				1
Shell Creek	2	4.25	33.5	725			
Sheep Creek	2	6.	77.	6,000			
Sheridan Creek	2	2.	19.9	200			
Smith Creek	1	.25	7.5	240			
Solitaire Creek	15	30.65	86.65	6,020			
South Owl Creek	3	3.55	19.	840	1	1	1
South Pass Creek	5	13.7	64.4	6,460		3	
South Fork Crazy Woman	6	5.68	40.78	1,055			
South Shell Creek	3	2.75	21.55	560			
South Fork Rock Creek	1	1.5	25.	1,500			
South Fork South Twin Creek	1	2.		300		1	
South Fork Tongue Creek	6	9.05	16.98	10,110		1	
Spring Creek	9	10.6	232.54	4,925	1		1
Steel Creek	1	1.25	5.5	200			
Stinking Water River	2	1.5	10.	80	1	1	1
Tatlow Creek	1	2.	8.	200			
Ten Sleep Creek	4	4.55	232.26	1,860			
Tapet Creek	1	4.75	25.	1,900			
Timber Creek	3	3.66	74.	1,320			
Tongue River	7	16.375	90.63	2,030			1
Trabing Creek	1	5	16.5	100			
Trail Creek	3	3.5	23.5	560			
Trapper Creek	1	.875	14.	320			
Twin Creek	1	1.5		440		1	
Wild Cat Creek	3	2.25	4.	200	1	1	1

Ditch record, water district No. 5—Continued.

Name of stream.	No. of ditches.	Length.	Capacity	Acreage.	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
reek	5	16.025	138.71	7,900	.....	.....	.....
mon Creek	1	33	3.	120	.....	.....	.....
ek	21	37.395	545.95	10,845	2	1	2
reek	4	7.25	1.	570	.....	3	2
anch Park Creek	1	4	3.4	150	.....	.....	.....
al	502	996.389	10,422.70	440,540	32	57	50

Ditch record, water ditch, No. 6.

eek	3	.93	10.8	1,760	.....	.....	.....
Creek	1	1.	1 8	65	.....	.....	.....
reek	7	11.5	193.1	4,820	4	2	4
reek	2	.....	5.42	.....	2	1	2
rche River	5	.....	.....	.....	.....	.....	.....
il Creek	1	.....	.....	.....	1	1	1
River	1	4.	3.87	3,840	.....	.....	.....
anch Sundance	2	1.5	3.40	31	.....	.....	.....
n Creek	1	.....	.....	.....	1	1	1
Skull Creek	1	.....	.....	.....	1	1	1
ver Creek	3	14.5	06.	3,000	.....	.....	.....
ou Creek	1	.....	5	.....	1	.....	1
ent Creek	2	.....	.....	.....	2	2	2
pring	1	.....	5.	.....	1	.....	1
k	2	3.6	33.3	1,020	.....	.....	.....
Creek	3	2.	18.47	200	.....	.....	2
rn Creek	5	12.5	06.22	2,741	1	.....	1
ver Creek	3	3.5	3	800	1	1	1
wder River	2	7.	24 05	135	.....	.....	1
ek	1	1.5	5.18	400	.....	.....	.....
n Creek	1	25.	2.5	.....	1	.....	1
ver Creek	2	18.1	10.8	5,850	.....	.....	.....
reek	1	.....	.....	.....	1	1	1
eek	2	2.	4.23	.....	.....	1	2
Creek	1	.....	.....	.....	1	1	1
nek	3	2.75	10.25	450	1	1	1
dwater	1	1.	14.	80	.....	.....	.....
Butte Lake	1	3.	20.	200	.....	.....	.....
dwater	2	1.	19.98	275	1	.....	.....
Spring	1	2.	12.	100	.....	.....	.....
e Springs	1	1.5	.....	.....	.....	1	1
	3	3.5	200.	1,280	2	2	2
eek	2	.5	.....	.....	1	2	2
Creek	1	.....	.....	.....	1	1	2
k	4	1.85	211.27	160	.....	3	2
e Cave	1	4.	.....	.....	.....	1	1
Cañon	1	.5	72.	10	.....	.....	.....
k Beaver Creek	2	30.5	15.2	10,320	.....	.....	.....
ver Creek	1	1.7	5.85	200	.....	.....	.....
nance Creek	4	2.25	47.	080	.....	.....	.....
dwater Creek	2	1.75	30.	280	.....	.....	.....
nch Redwater Creek	1	3.	6.85	.....	.....	.....	1
Beaver	3	20.2	9.6	10,530	1	1	1
er Creek	1	2	30.	100	.....	.....	.....
ek	4	3.625	9.0	575	.....	1	2
nch	4	.....	.....	.....	4	4	4
	6	.....	2.375	.....	6	3	6
Springs	1	.....	.....	.....	1	1	1
Creek	7	1.7	73.55	560	4	1	3
k	9	17.	301 86	6,160	1	1	1
al Creek	1	.5	3.4	80	.....	.....	.....
	4	2.5	3.5	100	3	2	3
al	124	196.955	1,556.325	58,162	46	36	55

Ditch record, water district No. 7.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Alkali Creek	1	6.				1	
Antelope Creek	2	3.	4.	640		1	1
Bear River	71	140.32	423.269	37,226.78	13	52	21
Big Muddy Creek	5	3.3	19.5	300	2	2	2
Beaver Creek	1	1.25	4.	160			
Birch Creek	5	5.5	1.4	2,880		3	
Bridger Creek	2			2,444	2	2	
Burnt Forks	2	2.5	66.1	900			1
Byrnes Creek	2	3.	3.	80	1	1	1
Byrnes Creek (branch of)	1	1.75				1	1
Boiler Springs	3				3	3	3
Coyote Creek	1	.5	2.	160			
Chalk Creek	1	.5	3.5	160			
Clear Creek	5	4.5	27.	1,380	1	1	1
Cedar Creek	1	3.	2.	1,280			
Cottonwood Creek	2	8.	86.	3,200			
Chappo Creek	2			160	2	2	1
Dry Piney Creek	6						
East Branch Sulphur Creek	1	1.25	3.	50			
Fontello Creek	11	15.5	62.91	2,500		4	3
Rawson Cañon	1	.25	.75	80			
Green Canyon Branch	1		2.125		1		1
Grape Canyon	1			160	1	1	
Hydraulic Creek	1	8.	8.	1,280			
Henry's Fork Creek	2	2.25	8.02	320			
Hams Fork Creek	18	33.5	102.875	8,040		8	2
Hard Creek	1	.5	.5	160			
Kasto Creek	2	4.	5.	280		1	1
La Barge Creek	9	27.	113.63	5,830		1	1
Little Creek	1	1.5	6.	160			
Little Muddy Creek	13	33.875	39.5	3,120		2	2
Muddy Creek	5	7.	31.808	2,280		1	1
Mill Creek	14	32.2	94.86	4,780		4	5
North Lake	1	4.		1,300		1	
North Piney Creek	3	6.5	22.612	1,480		1	1
North Fork Muddy Creek	2			160	2	2	
North Twin Creek	4	3.5	8.5	720			1
North Spring Creek	1	.5	4.5	60			
North Branch Clear Creek	1		4.375		1		1
North Branch of South Fork Little Muddy Creek	3				3	3	3
Quackenasp Creek	1	.33	3.	120			
Pine Creek	6	4.35	42.	2,440	1	1	1
Pine Cañon	1	1.5				1	1
Pleasant Valley	1			16	1	1	
Pine Grove Valley	1	.5	.084	120			
Poison Creek	1	.75	2.5	160			
Piney Creek	9	6.5	16.921	320	7	2	5
Raymond Creek	1			280	1	1	
Rock Creek	2	4.	6.	400	1		1
Republican Creek	1	1.1	13.02				1
Sulphur Creek	10	9.	48.5	1,210	3	5	5
Sulphur Spring Cañon	1	1.				1	1
South Spring Creek	1	1.5	2.	160			
South Twin Creek	2	2.	3.5	360		1	1
South Fork of Twin Creek	5	8.	14.6	1,670	1	1	1
South Piney Creek	1	8.	8.	640			
Spring Creek	9	8.	20.5	1,300	1	5	4
Sucker Springs	2	3.75	17.354	2,640			
Springs	10	11.5	38.18	825	2	4	3
South Branch Smith Fork Creek	1	.75				1	1
South Fork Smith Fork Creek	7	8.5	57.	2,795			
South Fork Creek	9	12.	65.	3,500			
Sportleff Creek	1	1.		200		1	
Stibbett Creek	8	5.75	9.41	490		5	6
South Lake Creek	1	5.5		130		1	
Samson Creek	1	5.	8.	120			
Salt Creek	1	1.5	4.	240			
Slate Creek	2	2.75	3.	320			
Twin Creek	4	14.75	43.703	5,520			
Tumers Creek	1	.75	8.	240			
West Branch Twin Creek	1	1	2.5	320			
Willow Creek	3	14.5	15.	800			1
Yellow Creek	7	7.705	51	1,080			
Leads Creek	1	5				1	1
Total	322	518.24	1,658.905	108,976.78	50	96	95

Ditch record, water district No. 8.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Ashworth Creek	2	1.8	12.116	160	....	....	1
Alkali Creek	1	2.7	2.	160	....	....	....
Big Popo Agie	14	28.424	291.19	6,355	1	3	5
Big Popo Agie and Middle Fork	1	.....	.....	.....	1	1	1
Big Popo Agie and New Fork	1	.04	.....	.....	....	1	1
Big Hermit	2	.....	.....	.....	2	2	2
Baldwin Creek	13	16.814	159.02	2,435	....	3	3
Beaver Creek	5	10.75	60.	2,600	2	3	3
Badwater Creek	2	2.	300.	160	..	1	1
Bridge Creek	2	.....	.....	.....	2	2	2
Bonner's Creek	1	1.062	13.5	160	....	....	....
Big Sandy River	1	.....	.....	.....	1	1	1
Big Beaver	1	.....	.....	.....	1	1	1
Bohack Springs	1	.....	.....	.....	1	1	1
Big Spring Creek	1	.75	3.	80	....	....	....
Big Sulphur Springs	1	.875	1.	120	....	....	....
Buffalo Creek	1	3.333	.....	.....	....	1	1
Cherry Creek	1	1.4	10.2	100	....	....	....
Cottonwood Creek	2	1.75	7.	120	....	1	1
Crooked Creek	1	1.3	10.5	250	....	....	....
Carter Creek	1	.25	125.	.....	....	1	1
Christiana Lake and Big Popo Agie	2	6.	140.	.....	....	....	1
Dry Creek	1	.....	.....	.....	1	1	1
East Cottonwood	1	.75	25.	40	....	....	....
East Long Creek	4	2.4	12.59	620	....	....	....
East Timber Creek	1	2.3	.579	.....	....	....	1
Four Bear Creek	3	4.75	13.194	320	....	1	3
Frank Forks Creek	3	4.925	31.757	1,200	....	....	1
Grass Creek	1	1.3	25.	100	....	....	....
Gray Ball River	4	4.	27.2	1,280	3	3	3
Little Popo Agie	11	15.412	177.1	2 860	....	....	....
Little Cañon Creek	2	.....	.....	.....	2	2	2
Little Sandy Stream	1	.....	75.	.....	1	....	1
Mexican Creek	1	.....	.....	.....	1	1	1
Meeteeke Creek	9	8.45	80.007	1,130	3	3	4
Meadow Creek	1	.25	.....	.....	....	1	1
Marguette Creek	1	1.	.....	.....	....	1	1
North Fork Willow	1	.75	.....	.....	..	1	1
North Fork Big Popo Agie	3	1.7	17.00	240	2	2	2
North Fork	5	17.05	167.25	5,120	....	1	1
North Fork Owl Creek	1	2.	640.	.....	....	1	....
Owl Creek	3	2.	90.157	600	1	....	....
Oregon Ditch	2	4.5	.....	.....	1	2	2
Picketta	2	.4	11.	80	1	1	1
Papypo Creek	2	1	15.561	120	....	....	1
Pat O'Hair Creek	4	10.75	32.1	1,660	....	1	....
Rock Creek	8	10.25	183.857	3,040	3	3	5
Squaw Creek	6	2.7	30.1	115	2	3	4
Silver Creek	1	.....	.....	.....	1	1	1
Sheep Creek	3	1.	1.3	.....	1	1	2
Sage Creek	4	8.	29.178	800	1	2	3
South Fork Owl Creek	1	1.	.....	600	....	1	....
South Owl Creek	1	1.5	.....	.....	....	1	1
Stinking Water	1	.....	.....	.....	1	1	1
Sweetwater	2	.5	29.1	.....	1	1	2
Trib Rock Creek	1	.....	.....	.....	1	1	1
Spring Branch North Fork Willow Creek	1	.....	.....	.....	1	1	1
Twin Creek	13	7.25	86.55	470	7	8	9
Timber Creek	3	8.6	74.	1,320	....	....	....
Willow Creek	12	8.375	66.59	480	3	7	8
Warm Spring	1	.6	5.5	100	....	....	....
West Timber Creek	1	.6	.231	.....	..	....	1
Wood River	1	1.9	28.	400	....	....	....
Total	182	212.41	3,059.487	35,395	52	79	96

Ditch record, water district No. 9.

Name of stream.	No. of ditches.	Length.	Capacity.	Acreage.	No. of ditches, omitting length.	No. of ditches, omitting capacity.	No. of ditches, omitting acreage.
		Miles.	*Cubic feet.*				
Birch Creek	2	3.5	27.	1,440	....	....	....
Cottonwood Creek	2	7.	.....	3,360	....	2	....
Clear Creek	8	16.	15.	6,080	....	7	2
Cedar Creek Springs	2	1.5	68.	480	....	....	....
Crow Creek	3	13.5	.....	17,560	....	3	....
Dry Creek	1	1.25	7.	320	....	....	....
Elkhorn Creek	1	.75	.....	160	....	1	....
Lost Creek	1	4.	18.	160	....	....	....
Nicholas Spring Branch	2	2.	10.	160	....	....	....
Red Creek	3	3.25	.....	840	....	3	....
Springs	2	.75	2.5	160	....	1	....
Slump Creek	3	2.5	.....	740	....	3	....
Salt Creek	8	18.	56.5	7,480	....	4	....
Spring Branch	1	.5	3.	160	....	....	....
Sulphur Creek	2	2.5	28.	320	....	....	....
Spring Creek	1	1.5	15.	320	....	....	....
Strawberry Creek	3	8.5	61.	1,760	....	....	....
Swift Creek	2	3.68	25.	800	....	....	....
Vail Creek	1	.75	6.	160	....	....	....
Willow Creek	1	.....	.....	.....	1	1	1
Total	49	91.43	342.00	42,480	1	26	1

Ditch record, water district unnamed.

Alkali Creek	1	2.53	2.	160	....	....	....
Big Spring	1	.75	1.3	80	....	....	....
Big Sulphur Spring	1	.875	1.	120	....	....	....
Cottonwood Creek	1	2.25	50.	2,500	....	....	....
Pacific Creek	1	1.	3.	320	....	....	....
Sage Hen Creek	1	2.	4.5	400	....	....	....
Stinking Water River	1	2.5	75.	600	....	....	....
Total	7	11.905	136.8	4,180	....	....	....

IRRIGATION, PUBLIC LANDS, AND CANAL CONSTRUCTION.

No. II.

[This paper was read by Engineer Meade to the committee.]

As the official head of the irrigation systems of this Territory, I have the honor to present this statement describing its agricultural resources and possibilities by the aid of irrigation, the character and extent of the work already performed, and of explaining the views of our people as to the measures necessary to secure the full utilization of our water supply in reclaiming the unoccupied arid lands.

Among the arid Commonwealths Wyoming stands the third in the extent of her irrigated land, while in the excellence of her laws and the legislative measures for the promotion of this interest she deserves even a higher rank. Although the youngest of the Territories and suffering greatly from the lack of railroad facilities, particularly between the agricultural districts of the north and the mines in the south, only California and Colorado surpass her in the mileage of canals or the area of land watered therefrom. This rapid development has been due to two causes, the first being the exceptional natural advantages of the Territory as a grazing region, and which at an early date made the raising of cattle its most important industry. With the cattle man to open the way and make settlement possible, the farmer soon followed. And as the necessity for winter feeding became apparent, the profits of the cattle business were invested in the construction of ditches to enable such food supplies to be grown.

The second reason is found in the abundance of the water supply and the ease and cheapness with which the waters of the streams can be diverted. The description of these streams and the nature of the works already built to divert their waters is given in Appendix A, attached to this report. It will be sufficient here to state that the principal streams have their sources in mountains of sufficient elevation and extent to make them abundant accumulators and conservators of the needed moisture, and that from these natural reservoirs these fruitful arteries of our agricultural life penetrate every section of our broad area. No other arid State or Territory equals this in the number of its streams whose waters can be diverted or in the uniformity of their distribution over its entire area. The location of the natural water-courses is such that if they carried sufficient volume of water all the lands could be easily and cheaply watered, while, on the other hand, there is but little land which would not be made productive if the water could be had. Hence it is that no subject has to this Commonwealth the same ultimate importance as the proper conservation and use of all water that falls on its surface.

The solution of the problem of how best to accomplish this involves an inquiry into two matters, first, the proper distribution of the water over the land, and, second, the conservation and storage of the flood water and the water running to waste in the non-irrigating season. In considering these questions regard must be had of the works already built and of the methods adopted and in practice among the farmers of the Territory, since no methods can be successfully carried out which do not accord in a measure with the views and interests of those already in the work. While the area irrigated is far less than that awaiting reclamation it is too important to be lost sight of in any plans for future work. The ditches now in operation and the acres of land which they water have involved the outlay of many millions of dollars of the earnings of our citizens. When they began their work the success of agriculture by irrigation was problematic. It was through their confidence and energy that the country now understands and appreciates its value and importance, and it is their efforts which has given the arid region whatever value it has. Hence, no action should be sanctioned which does not promise to promote the financial success and prosperity of the works already constructed. While the northern part of the Territory has outstripped all other portions in the extent and value of its irrigated lands, in all sections the construction of ditches has reached a surprising degree of importance and there is no portion in which the agricultural lands do not form an important part of the natural resources.

Much of the work done is faulty, resulting in heavy and unnecessary expenses for operation and maintenance and great loss of water in distribution. We have too many small canals watering the bottoms and not enough large canals watering the uplands. Our methods and system need reforming to prevent this in the future work. It is the result in part of the lack of means and experience on the part of the pioneer ditch-builders, but very largely of late years of the unfortunate circumstances of our land laws being wholly unsuited to the conditions of this region, and of their administration being in the hands of men ignorant of these facts.

It is a well-settled principle that lessening the number of ditches by building large high level canals results in both economy of water and saving in operating expense. It also, as a rule, secures the watering of more fertile and productive land. To build large ditches, however, requires either a community of effort on the part of the farmers owning the land or the introduction of capital to build canals to rent water. The first plan has seldom been successfully pursued. The length of time required to prepare for and complete the construction of a large canal, and the fact that farmers can produce nothing to support themselves or their families until this is accomplished, has prevented its successful adoption. Hence the majority of the large irrigation works have been built as common carriers of water, this plan seeming to best meet our conditions and needs. There is no objection so far as I am aware and many things in favor of this plan, provided the canals are properly built and furnish water at a reasonable rental. They are a necessary and valuable feature of our irrigation development, and we should have such laws as will make the investment a safe one and secure their construction under such conditions as will enable them to furnish water to farmers at a minimum cost.

Unfortunately, however, the building of large canals to furnish water to the settlers on the public lands gives rise to a condition of affairs which, while well understood here, is apparently not appreciated elsewhere. Before the canal is built these lands are valuable only for grazing purposes, which value in most cases does not exceed 50 cents per acre. The construction of the canal, however, carries with it the assurance of their reclamation, enhancing their value to that of farming land, so that without the purchase of a water right or without the owner of these lands having in any way contributed to their improvement their value is increased at a low estimate from $5 to $15 per acre. This unearned increment is due entirely to the expenditure and efforts of the ditch company which expects its return from the rentals of water to the settlers on the lands thus made susceptible of cultivation. If there-

fore all filings under the ditch were made by persons expecting to become cultivators of the soil, and who would at once become users of the water, no harm would ensue. Unfortunately, however, our land laws make possible an entirely different result. The increase in value resulting from the construction of the ditch is a rich field for the speculator. Parties having no desire or intention of becoming farmers can through the pre-emption law, the homestead law, and the timber-culture law obtain possession of 480 acres of this land without having to rent a gallon of water from the ditch company or in any way contributing to its maintenance or advantage. By the expenditure of 25 cents per acre they can in the same way obtain a three years' option on 640 acres additional by desert entry. Thus it is that over a thousand acres of land are withdrawn from honest settlement and the speculator or entryman is in a position to blackmail the ditch company, as it is only by its buying him out and disposing of these lands to bona fide farmers that it can derive any income from the water supply. This situation of affairs has made it impossible in this Territory to construct large ditches simply as common carriers of water. The success of the enterprise makes it necessary that the lands should at once be brought under cultivation, and to accomplish this there must be some control over their settlement. This neither the ditch company nor the Territorial authorities can attempt at present.

There are in the Territory a number of important canals built to rent water and all have suffered from the difficulty of securing a prompt settlement of the land reclaimed. Some of these have endeavored to protect their investment by securing this control of the lands, the most important instance of this being the Wyoming Development Company, its field of operation lying about 90 miles north of this city. It began originally with the intention of furnishing water to the farmers, but it soon became manifest that unless they could control the settlement of the lands that the only parties to derive any benefit from their efforts would be the parties filing on the land, and that if the lands were to be actually made productive they must take steps to control their settlement. This was done and in this work and in the construction of their canal about $500,000 was expended. The enterprise has been in every respect a most praiseworthy one. Over 50,000 acres of land have been watered by one of the best systems of canals to be found anywhere in the arid regions, yet owing to the lack of appreciation of the real situation of affairs and of the necessities of this region these lands lie idle and unproductive in the hands of the Government, and the projectors of one of the best enterprises yet inaugurated in this Territory have been put to the expense and annoyance of maintaining for five years a system of costly and unproductive irrigation works. The unfortunate outcome of this company's operation has been in the widest sense a disaster to the Territory. Its example is a menace and a virtual barrier to the inauguration of other enterprises of special magnitude, and has resulted in a return to the original practice of building small ditches, where each individual could manage and control his own claim, the opportunities presented for the diverting of water making possible an extraordinary development of this nature. The evil consequences of this state of affairs are many. It creates a system difficult to control, expensive to operate, and wasteful of water. Not only that, but many of our best lands can only be reclaimed through the medium of extensive and costly works. If during the past five years we could have had a system of land laws that would have enabled ditch companies to have secured actual settlers on the lands reclaimed, the number of important irrigation works and the extent and wealth of the irrigated territory would be fourfold that which exists.

A proper utilization, however, makes it desirable that additional changes, besides reforming our land laws, should at once be made. Since the area of land which can be irrigated is greater than the available volume of water, it is desirable that our irrigation works should be so located as to serve the best of these lands, and that the water supply should be so distributed as to insure the utmost economy in its use. To do this it is necessary that a careful examination of the streams should be made in advance of irrigation construction, and that these works should be built in accordance with an intelligent system and plan. It is further to the interest of the State that this should be done, since it is charged with the responsibility and expense of supervising these works after they are built and with the division of the water among the various claimants. Under the haphazard system which has heretofore prevailed, where there has been no limitation or supervision as to the number, location, and character of the works for diverting water, it becomes a practical impossibility to secure a just or satisfactory distribution of the water supply in a time of scarcity.

The ill results of this policy become more pronounced the longer it is pursued. They are more notorious in Colorado than with us, and will be felt here in ten years far more than at present. It is a counterpart of the old land system, or lack of system, which formerly prevailed in this country and in some of the Eastern and Southern States, where each settler blazed out his domain according to his inclination, regardless of the boundaries or rights of his neighbors. The litigation and ill-feeling which followed as a legacy of this practice in Kentucky and other States promises to be repeated in our water-right troubles if some more enlightened policy be not

adopted. That our system is what it is is not due to the lack of appreciation of its defects on the part of our people or the want of the knowledge of a remedy. It is a system forced upon us by necessity, not choice. A Territory sparsely settled, with its resources undeveloped, was not in a situation to undertake any systematic public improvement or investigations, nor can we accomplish anything satisfactory towards this end with the public lands owned and controlled by the General Government. It is useless to make any investigation or examination as to the proper location of irrigation works while no control can be exercised over the settlement of the land.

The most satisfactory remedy for this state of affairs, and, in my judgment, the only efficient one, is for Congress to grant to each State of the arid region, or to each Territory upon its becoming a State, all the irrigable lands within its borders held by the General Government, such States to be charged with the supervision of their reclamation and with their disposal to actual settlers.

The reasons for asking this donation were stated in a letter prepared by a committee appointed at a conference held in this city in July last, and I can do no better than repeat them here:

"First. The reclamation of the lands of this region lays upon the people engaged and upon our local or State government requirements and expenses not encountered by the pioneer of the humid portion of the country. Not only does the construction of ditches and other distributing works add greatly to the first cost of a farm, but with their multiplication comes the necessity of the State assuming control of the distribution of the water supply, and its failure to do so leads inevitably to expensive litigation or to personal controversies which impair both the success and the growth of our agriculture. A further incentive to prompt action is the fact that the area of land susceptible of reclamation exceeds the amount of water supply. The water, therefore, possesses a greater value than the land, and on its economical distribution rests the limit of our future agricultural wealth. It is of the utmost importance, therefore, that no wasteful or improper diversions be permitted, and that the State should control the appropriations of water as well as its subsequent division among the various claimants. The expense of this work must of necessity be heavy. In Wyoming there are already two thousand five hundred ditches drawing their supplies from four hundred water-courses, and this work is yet in its infancy. In Colorado, with its greater advancement, the single work of regulating the division of the water supply requires the employment by the State of nearly one hundred men. This regulation is a necessity not to be avoided, but the preliminary examination of our streams and an efficient supervision of the construction of works to divert the water therefrom is of equal importance to our future welfare. In our present condition it will, however, be a practical impossibility for many of the States and Territories to provide means for this work by taxation; but the funds for its prosecution can be easily provided for in the disposal of the lands whose donation is asked.

"Second. Our experience during the past five years has shown the evils growing out of the control of the land being under one authority and the water under another.

"If this Territory could during the past five years have controlled the disposal of the irrigable lands within its borders, it could, while disposing of it to actual settlers only, have afforded such protection to canal companies as would have given our agriculture four times its present importance, and more than doubled our population. Instead of this there have been repeated instances where arbitrary and unreasonable rulings have subjected our people to heavy and wholly unnecessary expense, and to cause the whole land policy to be regarded as oppressive. It was, however, the inevitable result of land laws wholly unsuited to the needs of irrigation, and of their enforcement by officials in Washington whose experience had not prepared them to deal with the conditions which exist here.

"It is also impossible for Congress to pass a general law which will operate with equal justice and success on the arid belt as a whole. The conditions differ in the different sections as do our water laws. Wyoming differs from Utah, and Arizona from Montana or Idaho. The people of each section are the best calculated to determine the system best suited to their needs and should be given the means of carrying it into effect.

"Third. The results already achieved are a sufficient guaranty of what can be accomplished under favorable circumstances. Our legislation as to water has, on the whole, been wise, but it can never have the stability or success which would come with the control of both water and land. Our engineering works have elicited the praise of experts from other irrigated countries for both their economy of construction and adaptation to their use. At present the practical knowledge of the subject is almost wholly confined to those engaged in the work. The information gained through the labors and investigations of the geological survey can be utilized by local legislatures, while by placing the responsibility for this work upon our people a great impulse will be given to the diffusion of intelligence on the subject and to local pride in the character of our irrigation works. It will put the solution of this

problem in the hands of the people best informed on the subject and most interested in its success.

"We will say further, that our people are afraid of the proposed withdrawal of the irrigable lands from settlement or the placing of the construction and control of our irrigation works under the charge of the National Government; the reason being in both cases that the delay and uncertainty which would be inseparable from such action would be disastrous. While the passage of laws to encourage individuals or companies to reclaim large bodies of arid lands would most speedily accomplish the desired end, namely, reclamation and settlement of the arid regions, yet public sentiment seems to be so adverse to this plan that we feel that it is scarcely worth our while to advance it."

The dangers attendant upon national legislation is shown in that clause of the law creating the irrigation survey which provides for the repeal of all land laws except the homestead act. This change has met with the disapproval of all persons acquainted with the situation in this Territory. To limit the acquirement of title to the public lands to the provisions of the homestead act would be disastrous restriction on settlement and there is no valid reason for its adoption. It offers no aid toward the construction of better works or the more economical diversion of water, the most important consideration connected with the whole subject. In this respect the desert land law was the best ever enacted, if it had been liberally construed or if the rulings of the land office had been uniform as to its meaning. The difficulty has been that the changes in the rulings have been of so radical a character as to practically constitute new legislation and to cause much hardship and expense to those honestly endeavoring to comply with the law. So onerous have been some of the restrictions that it has seemed as though the authorities regarded every claimant of the public lands as an object of suspicion who was guilty until proven innocent. It is time that more sensible and just conception prevailed. Every settler on these lands which in their present condition have no agricultural value, and who reclaims them and makes them productive, is a benefactor of the whole country and should receive the most liberal treatment. Instead, however, after having expended from $5 to $15 per acre in bringing the water on his land and preparing it for irrigation, he is compelled to pay the same price therefor that the settler on the broad prairies of Iowa and Kansas paid for land already prepared for the plow.

The commonwealths who are charged with the duty of guarding the public welfare should be aided in their efforts. Every consideration which justified and secured the donation of the swamp lands to the States of the humid region applies with greater force to the advisability of a similar donation of the arid lands to the several States and Territories interested. Not only are our local governments charged with heavy duties and responsibilities which none of the humid States had to confront, but the settlers who come here to engage in farming undertake the practice of an art whose mastery is both complicated and difficult, and of which they have had no previous experience. Our climatical conditions are exceptional, making much of our agriculture and experiment, and making certain that we are far from pursuing the best methods or that we are achieving anything like the results which are possible. The local government should aid private effort by conducting experiments to determine the best methods, and by disseminating information which will enable new comers to obtain their knowledge of the subject by some less difficult and costly road than that of experience. The success of irrigated agriculture enormously increases the value of the arid domain, and will be an important contributor to our national wealth and prosperity. The best results can only be secured through the nation's aid. I trust it may be generously extended.

TERRITORIAL ENGINEER'S REPORT TO THE GOVERNOR OF WYOMING.

[Copy with the committee, by Engineer Mead.]

No. III.

The work of this department may, for convenience, be divided into four classes, as follows:

(1) Preparation of instructions for water commissioners to enable them to perform their duties in accordance with the court decrees determining priorities.

(2) The gauging of canals and preparation of tables showing discharges of the various ditches; these tables to be furnished to both the commissioner and ditch-owner.

(3) The recording of decrees and recording and calculation of engineer's certificates as required by law.

(4) The gauging of streams, examination of reservoir sites, collection of data showing the location and extent of our irrigation resources, and such other work as will extend our knowledge of irrigation and advance our agricultural interests.

A beginning has been made in the work of each of these divisions. Three decrees have been rendered in District No. 1 and one in District No. 8, all of which have been recorded, and the proper instructions have been given the commissioners.

No gauging of ditches have as yet been made, but plans and instructions for the construction of measuring flumes have been prepared and furnished to the various ditch-owners, and the work of gauging these will be the first work to engage my time next spring.

A part of the present irrigating season was given to the gauging of streams and the examination of irrigation work. The tour of investigation began in May and ended in August, and included a large part of Laramie, Albany, Johnson, and Sheridan Counties, together with visits to Sweetwater and Uinta Counties.

Without attempting a detailed report of this examination it may be well to mention some of the conclusions to which it led.

The soil wherever examined is fertile, and wherever irrigated becomes exceptionally productive. Grasses and the hardier grains and vegetables do well in all parts of the Territory, but in some localities the elevation is too great to successfully grow corn and some kinds of vegetables. The eastern and northern portions of the Territory are able to produce nearly all kinds of fruits and vegetables grown in temperate regions, the lower elevation of the northern part (3,500 feet at Sheridan) compensating for the difference in latitude.

A distinctive feature of Wyoming's irrigation is that it outstrips all the States and Territories of the arid region in the number of its streams available for irrigation. The valleys bordering most streams are narrow, varying in width from one-half to 5 miles, and the uplands between these valleys too high to be watered, and which must remain as grazing land. This contiguity of large tracts of grazing land to that devoted to farming, affording as it does free summer pasturage for the farmer's stock, is a material advantage and is destined to increase the profits of the farmer and greatly enhance the value of the irrigated lands.

The counties of Albany and Laramie furnish the best examples of ditch building, the largest and best constructed ditches being found there. The irrigation works of these two counties also must nearly utilize the waters of their streams, on a majority of which the aggregate capacity of the ditches exceeds the average discharge of the stream during the irrigating season, and the further extension of the irrigated territory can only be accomplished through the construction of reservoirs to store up the surplus water of the spring floods. The fertility of these lands, and their nearness to a market for their products, make it extremely desirable that such works should be built, but their cost puts the work out of the field of individual effort.

In nearly every part of the Territory visited there are favorable locations for the investment of capital in the construction of irrigation works of too great magnitude for farmers to attempt; these no doubt will be utilized in the near future. It will be seen, however, in the statistics given further on in this report, that if the lands in this territory now under ditches, and susceptible of being irrigated, were being cultivated, Wyoming would take rank as an important agricultural commonwealth. At present, not one-twentieth part of this land has ever been tilled, the reason being found in the lack of railway facilities for transporting the produce of the farms to market, and in the lack of means on the part of the farmers to bring their lands under cultivation. Construction of laterals, and other work necessary to reclaim arid lands, entail a heavy burden of expense the first few years. In no part of this country, however, can agriculture be pursued with more success and profit than in this Territory, and the present condition of affairs must soon disappear.

DITCH STATISTICS.

One of the first needs which impressed itself upon me in the discharge of my duties was the almost indispensable necessity for having in this office a record of the ditches already built, together with the data showing their size, location, and data of construction. This information could only be had through an examination of the "claims to water" recorded in the offices of the various county clerks throughout the Territory. To properly examine these records, and make the necessary abstracts from them, required the expenditure of considerable time, but the importance of the record seemed to justify its being undertaken.

Below is given a tabular summary of the irrigation development of the Territory as far as the records have been completed; the statistics for Carbon and Fremont Counties having not as yet been compiled.

In preparing this summary, wherever the length, capacity or acreage of a ditch was omitted in the statement of claims, no attempt was made to supply the omission, nor has any addition been made to the totals on account of such omissions, while the tendency of statements is to exceed the actual facts, the fact that 20 per cent. of the statements failed to give the acreage and about 10 per cent. omitted giving the length will make the totals rather below than above the truth.

When the statistics of Carbon and Fremont counties are added to those below, it will increase the acreage under the ditch, and capable of being irrigated, to over 1,600,000 acres.

Table showing extent of irrigation in Wyoming.

County.	No. of ditches recorded.	No. of ditches omitting statement of length.	Length as given.	No. of ditches with statement of capacity omitted.	Capacity of those given.	No. of ditches with statement of area irrigated omitted.	Area irrigated by ditches given.
					Cu. ft. per sec.		
Albany	333	37	488.75	45	6,894.99	69	345,261
Crook	115	26	198.90	45	883.17	61	65,917
Johnson*	434	32	738.68	56	2,117.20	143	282,230
Laramie†	280	20	1,122.39	42	4,200.60	79	396,233
Sweetwater‡	21	4	178.3	15	.....	13	4,200
Uintah	270	37	451.3	86	1,333.97	83	197,453
Carbon§	.....	.....	.....	.....	.....	.....	.....
Fremont§	.....	.....	.....	.....	.....	.....	.....
Total	1,718	167	3,208.30	288	21,327.33	367	1,291,294

*Includes Sheridan County. †Includes Converse. ‡Statistics very incomplete. §Not completed.

In the examination of these statements of claims it was found that in many of them essential facts were omitted and immaterial and irrelevant matter included, thus lessening the value of the record and greatly increasing the labor of examining it.

Believing that these incomplete statements were due to ignorance of what our law required, rather than to carelessness or neglect, and realizing that these imperfect records were likely to prove a fruitful field for controversies and expensive litigation, I took what steps lay in my power to secure the filing of complete statements in the future, by preparing a standard form of statement, which was mailed to the various county clerks with the following letter:

To the appropriators of water:

"An examination of a large part of the claims to water, now on file in the offices of the various county clerks of the Territory, has disclosed the fact that a wide diversity exists in the character of the statements contained in these claims.

"This is shown in the different orders in which the essential facts are arranged; in the use of the different units to designate the volume of water claimed, and in the various forms in which the dimensions and grades of ditches are expressed. This lack of uniformity proves a source of serious annoyance and perplexity to those who have occasion to examine the records. To reduce these varying units to a common standard, which becomes necessary whenever any use is made of these records, is a work involving considerable time and labor, which could be avoided by the use of a standard form in the original statements.

"Another, and more serious, defect which has been observed in these claims, is the failure of any to state all the facts necessary to the determination of the claimant's rights or his protection in them. These omissions include nearly every portion of a complete claim, but the most serious and numerous are the failures to state fully or properly the dimensions of the ditch or the volume of water claimed. The unit employed for the latter is often so indefinite as to be practically valueless. Claims for 'square inches,' 'agricultural inches,' 'California inches,' or 'miners inches' are decidedly out of place in this Territory, where the law recognizes no unit except the cubic foot per second.

"These incomplete statements are destined sooner or later to prove a source of serious annoyance, if not of expense, to the parties filing them, since, wherever an adjudication is had, the missing facts will have to be supplied.

"As an aid to secure the proper filing of these claims in the future, and the consequent protection of the rights and interests of claimants, I have prepared a standard form of claims, the use of which throughout the territory is strongly urged. The advantages of uniformity and systems to be secured by this means are so many and important that it is hoped that this request will, in all cases, be complied with.

"*Copies of this form have been furnished to all the county clerks and county surveyors of this Territory, who will doubtless make arrangements for their being readily obtained.*"

All the county clerks have co-operated with me in this matter with a resulting gain to the public in the convenience, system, and reliability of our water records, which only time will enable us to properly appreciate.

The volunteer weather service has also been established in connection with this office, the signal service loaning the necessary instruments. Five stations have been thus far established, each in an agricultural district, at which observations of temperature and rainfall are being made.

Before closing this report I wish to call attention to one or two matters which seriously embarass the working of our irrigation system, and which will require the early attention of our lawmakers.

The irrigation laws of this territory, taken as a whole, are perhaps in advance of those of any other State or Territory of the arid region. All irrigation legislation in this country has, however, been tentative and fragmentary. There has been no attempt to frame a complete irrigation code, but only to enact such laws as the immediate necessities of the irrigation interests seemed to demand; the result of which, owing to the rapid growth of the irrigation interest, is that legislation calculated for its regulation and protection has not kept pace with the conditions developed by its growth.

While the evils resulting from this state of affairs have not been so serious or apparent here as in Colorado or California, our present laws are in some respects wholly inadequate, and will need to be supplemented by additional legislation.

Over two thousand ditches have already been completed in this Territory, and have their claims to water on file in the offices of the various county clerks. These ditches water an area equal in extent to the whole of the irrigated district of France and Spain combined, and one half that of Italy. They are distributed throughout a region almost as large as the whole of New England; yet, at the time I entered upon the performance of my duties, the service of only one man was available for the work of dividing the water supply in accordance with their claims, and his time of service was limited to fifty days.

The scarcity of water which prevailed in many locations made the need of proper supervision unusually urgent.

Requests from prior appropriators, who were unable to secure their rights, came from all parts of the Territory asking for the service of water commissioners to regulate the division of the water supply. As there were no commissioners to act, and their authority to act in such cases was doubtful, nothing could be done. The need of some action was, however, so apparent that I referred the matter to the attorney-general, asking if there was any authority by which the water commissioner could divide the water of streams whose ditch rights had not been adjudicated. I append below an abstract from his reply.

"I have carefully examined the Revised Statutes of Wyoming, as well as the late laws enacted, and I find nothing either directly or by implication on our statute books which will give you as Territorial engineer authority to determine the priorities on any streams of this Territory, nor is there anything in the laws that would permit the water commissioner to divide the waters of any stream whose priorities have not been determined as directed by law, nor can he perform his duties previous to receiving the instructions set forth in section 9 above referred to."

This law, therefore, as it now stands, limits the work of water commissioners to those ditches whose priorities have been determined by the court. The right of less than 5 per cent. of the ditches of this Territory have been so determined, and to leave the rights and interests of the remaining 95 per cent. without protection or regulation until the courts can attend to them, will inevitably give rise to bitterness of feeling and to conflicts which will not only seriously retard our agricultural progress, but will for the next quarter of a century embarrass the introduction of proper supervision.

As ditches are now being built faster than their rights are being determined, it is manifest that some provisional measure should be adopted to secure proper regulations in the interregnum. The plan which would best subserve this purpose would be, I think, for the Territorial engineer to be authorized to instruct the water commissioners to divide water on all streams where regulation is necessary, the engineer basing his instructions as to the manner of division on the statement of claims now on file.

It is not designed that this should do away with the final settlement of the rights of claimants by the court. There should be the right of appeal to the court from the engineer's decision at all times, and the final decree of priorities should be rendered by the same authority. What is needed, and what it is believed the proposed step will accomplish, is the protection of the rights and interests of the pioneers of our agriculture until such time as the courts can properly attend to these matters.

In fact it is desirable in many cases that the determination of priorities should be deferred until the era of rapid ditch construction has ended, in order that all the ditches of a stream may be included in the adjudication, and that a second or third consideration of the matter, due to subsequent ditch construction, be avoided. Another advantage of delay in adjudication will be that farmers will be better informed as to

the nature of the laws and the importance of having their interests properly represented before the court renders the decree. That this is not now the case is shown in two of the decrees already rendered, where a large number of ditches already built were not represented in the proceedings nor included in the decrees.

Attention has been called to the defect in the present method of filing claims to water and the means employed to improve them. I am convinced, however, that the only effectual remedy lies in change from our present system which will provide for the examination of every claim before the filing. The tabular statement in a preceding part of this report illustrates the large number of omissions of essential facts exhibited in these statements. It does not, however, exhibit the imperfections of statement nor the irrelevant matter which encumbers so many and makes their examination or utilization so difficult.

While writing this report I was told by a farmer that in the filing of his claim he was obliged to make three visits to the county seat, a distance of 40 miles, and to pay for the recording of three statements before a correct record was secured. I have heard so many statements of the same character and have seen enough duplicate records to convince me that some radical change is necessary.

The remedy I would suggest would be—

First. To make it the duty of the Territorial engineer to prepare a standard form of water claim which shall embody the requirements of our present law; this form to be used by all persons filing claims to water.

Second. Every person wishing to file a statement of claim shall first forward a copy of such statement to the Territorial engineer, whose duty it shall be to examine this claim. If correct, he shall approve it and record it in his office and return the statement with his approval to the party making the claim, who shall then have recorded the approved claim in the office of the county clerk. If the statement forwarded to the engineer is imperfect or incomplete, it shall be his duty to return it for correction, designating the errors or omissions, which when remedied, shall be returned for examination as before, and if approved, to be recorded and returned as before stated.

The advantages which would accrue from this change would be, the engineer's office would at all times have a complete record of the location and progress of ditch building, and the public a source of information of the extent and character of our irrigation development. It would greatly improve the character of the record, making it more convenient to examine and preventing the filing of worthless statements. It would, by the correction of imperfect statements, serve as an educator, showing the ditch-owners the purpose and requirements of the law and would protect him from any annoyance and expense incident to the filing of such imperfect statements.

In calling attention to these features of our irrigation laws that need legislative revision, I have been more remindful of the demands of the future than of the disadvantages of the present. The subject of comprehensive irrigation legislation will be one of the most important to engage the attention of our next general assembly. The future development of our agricultural interests is certain to be rapid and important. As it is, with our irrigation system scarcely established, we have enough land under ditch and ready for the plow to make twenty thousand 80-acre farms, and to engage the efforts of a purely agricultural population of more than twice the number of all the people now in the Territory. Many of these ditches have been built under exceptionally unfavorable conditions; the best watered and most extensive agricultural districts being in the central and northern portions of the Territory, while, until within the past two years, all the materials and implements required in the construction of ditches, together with a large part of the provision for men and teams had to be hauled from the stations of the Union Pacific which traverses the southern border.

The transportation by wagon of all this material for distances varying from 100 to 300 miles almost doubled the cost of the work and materially lessened the prospect of profitable returns. So also the remoteness of a staple market and the difficulty and expense of obtaining the conveniences of life have been a serious drawback to many of our pioneer farmers. Where it required a three weeks journey to buy a plow, as it did until recently, in many cases there was not much plowing done.

The Territory still suffers from the lack of adequate railway facilities. There is a surplus of agricultural products in the north for which there is a ready market and good prices in the south. The completion of the railroads projected to bring these sections together will result in increased prosperity for both. It will encourage the cultivation of an increased acreage, and will make accessible to the capitalists a country now practically unknown.

In the counties of Johnson and Sheridan alone, the surplus water of the streams gauged by me this season would irrigate 500,000 acres, and I am reliably informed that there is double that extent of land susceptible of being watered. Were it necessary other illustrations of the same character could be given. It is certain, however, that agriculture is destined to be one of the most important, as it is one of the most stable, of the Territory's material interests and the perfection of the methods and practices on which its success and progress so largely depends should receive the most careful consideration.

ADDENDA TO TERRITORIAL REPORTS.

Attention is called to the table in the report giving the statistics of our irrigation development. Since that was written the corresponding statistics for Fremont and Carbon Counties have been compiled, and the result which follows more than justifies the statement in the report that there is land enough under ditches and susceptible of being irrigated to make twenty thousand 80-acre farms. The statistics are below the actual development, as many ditches have been built since the records were began and are not included, and a larger number have never been recorded. An addition of 25 per cent. to the totals would probably be nearer the actual situation.

Abstract from ditch records of Fremont and Carbon Counties.

	No. of ditches.	Length.	Capacity per second.	Acreage.
		Miles.	*Cubic feet.*	
Carbon Company	304	421.60	4,451.64	1,084.44
Fremont Company	181	226.27	.....	441.81

This makes the totals for the Territory, so far as completed, as follows:

Total mileage	3,852.83
Total acreage under ditch	1,413,404

Four-fifths of these ditches have been completed within the past five years. It is probably the most rapid development yet recorded in any State or Territory, and when considered in connection with our unfavorable conditions incident to lack of railroad facilities, and to the fact that the present land laws are not suited to the conditions of the arid region and their technical enforcement has oftentimes caused great hardship and unnecessary expense to the pioneer farmers, it furnishes a gratifying evidence of the superior inducements of our agriculture and the facilities here presented for the economical construction of ditches. Nearly the whole of this is the result of the efforts and expenditures of the farmers and cattlemen of the Territory.

Water district No. 8.—Claims to water as taken from the records of Fremont County.

Name of stream.	Name of ditch.	Dimensions. Length.	Bottom width.	Top width.	Average width.	Depth.	Grade per mile.	Amount claimed per second.	Date.	Number of acres under ditch.
		Miles	*Feet*	*Feet*	*Feet*	*Feet.*	*Feet*	*Cu. feet.*		
Ashworth Creek	.....	$\frac{9}{10}$	..	...	3	1	15.8	12	Aug. 26, 1886	160
	Ashworth Creek	$\frac{9}{10}$	..	..	.....	.....	.....	(*)	Sept. 2, 1885	.....
Alkali Creek ...	Alkali Ditch	$2\frac{7}{10}$	3	3.5	...	9	6.33	2	Nov 12, 1886	160
Big Popo Agie.	.....	$1\frac{1}{4}$	7	10	.....	3	.....	.....	Dec. 4, 1883	.....
	.....	$\frac{1}{4}$	1	1.5	....	.8	.....	.....	July 13, 1885	.....
	.....	$1\frac{1}{16}$	.....	...	....	.....	.....	(†)	Nov 13, 1885	.....
	Last Chance	2	.		4	1.5	5	14.3	July 29, 1886	180
	Gaylor Ditch .	...	3	5	.....	.....	5.3	.....	Mar 4, 1887	.....
	Cemetery .	4	5	...	...	1.5	10.5	32.1	May 5, 1887	900
	West End Ditch	$\frac{1}{2}$	..	...	2.7	1.5	47.5	18	May 23, 1887	15
	Dutch Flat ...	$2\frac{1}{2}$	6	.	.....	2.5	4.2	48	June 6, 1887	2,000
	Nicol and Meyers.	$2\frac{1}{10}$	4.5	7	...	1.2	5.2	9.5	May 18, 1888	400
	Hornecker Ditch	$3\frac{1}{2}$	3	5	.....	2.5	17.16	21	June 22, 1888	600
Big Popo Agie and Middle Fork.	.....	.....	....	....	.....	....	.....	.....	Jan. 29, 1886	.....
New Fork	.....	$\frac{1}{8}$	....	.....	2.5	2	.....	.....	Jan. 29, 1886	.....
Big Hermit	....	.....	...	...	....	. ...	....	.....	June 12, 1885	.....
	....	.....	...	...	.....	8.3	. ...	.... .	Aug. 12, 1885	.....
Baldwin Creek ..	....	$3\frac{1}{2}$	....	...	.....	..	.. ..	.....	June 17, 1885	.....
	First or Upper Ditch	$\frac{1}{4}$	..	..	2.5	1.25	.....	.....	Feb. 12, 1886	.....
	Second or Lower Ditch.	$\frac{1}{8}$	.	..	2.5	1.2	.....	.....	Feb. 12, 1886	.....
	Harting and Sharp.	$1\frac{3}{4}$	...	..	3.5	2	35	46	July 10, 1886	254
	Lum, Williams and Sharp Ditch	$2\frac{2}{10}$	.....	.....	4.5	1.25	38	38	July 10, 1886	351
	St. John Ditch	$1\frac{1}{16}$	...	.....	3	1.5	11.06	15.03	July 27, 1886	100
	Jones Ditch ...	$\frac{1}{2}$	....	.....	1.7	.7	31.7	5.2	July 15, 1887	80

* Claim 200 inches. † Claim 1,800 inches.

No. IV.

EVIDENCE PREPARED THROUGH CIRCULAR LETTER TO CITIZENS.

CHEYENNE, *August* 17, 1889.

Mr. ——— ———:

DEAR SIR: I desire to place before the Senate Committee on Irrigation a correct and impartial statement of our present agricultural development, together with the circumstances and conditions under which it has been accomplished.

As an aid in doing this I wish to obtain the statements of a large number of farmers in different parts of the Territory of the difficulties and expense attending their efforts to reclaim the desert and the results which they have obtained.

I mail you with this a list of questions which I trust you can find time to answer. I am particularly desirous of learning your experience under our present land laws and your views as to what changes thereto are needed. The evidence thus collected will be arranged and presented to the committee.

The modifications of our land laws effected by the last Congress and the probability of further action by the coming one makes it of the highest importance that our wishes and necessities be properly presented and understood.

I trust I shall have your aid and co-operation to this end.

Respectfully,

ELWOOD MEAD,
Territorial Engineer.

TERRITORY OF WYOMING, ENGINEER'S OFFICE,
Cheyenne, September 22, 1889.

I hereby certify that the accompanying letter, asking for testimony to be used before the Senate committee, and the responses thereto, are a full, true, and exact copy of the originals now on file in this office.

ELWOOD MEAD,
Territorial Engineer.

Name, ANDREW GILCHRIST; county, Laramie; post-office, Cheyenne.

1. How long have you resided in the Territory?—About fifteen years.
2. In what year did you begin farming?—In 1877.
3. How much land have you under ditch?—Personally, about 2,000 acres.
4. If obtained from the Government, state the filings which were made.—Lands entered under the desert, pre-emption, and homestead acts, and lands purchased from the Union Pacific Railroad.
5. How many acres are now under cultivation?—About 2,000 acres.
6. By what ditch or ditches is it watered?—By nine ditches, named "Gilchrist No. 1 to No. 9."
7. From what stream or streams is water taken?—South, Middle, and North Crow Creeks.
8. Give history of construction of ditch:

(*a*) Names of owners.—Andrew Gilchrist and Mary Gilchrist.

(*b*) Date begun and time occupied in building.—Began April, 1877; the last ditch was completed in 1887.

(*c*) Dimensions.—The nine ditches are of various dimensions.

(*d*) How many acres does it water?—The nine ditches water about 2,000 acres.

(*e*) What was the cost of construction?—About $10,000 for the nine ditches.

(*f*) What is the cost per year for management and repairs?—About $200.

9. Do you buy or sell water; if so, state price paid or received.—I neither sell nor buy.
10. Have you all the water needed; if not, state the reason.—No, not every year. In dry seasons there being but little snow in the hills the supply of water in the creeks is therefore limited, and the city of Cheyenne claims first appropriation for domestic purposes.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—About $10 per acre.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—From two to three years.
13. What did it cost you to prove up and obtain title to your land, and what was *the length* of time required? If any difficulties were encountered, state what they were.—*Cost* from $8 to $10 per acre. Difficulties encountered in obtaining title from

the Government are many, principally on account of the tardy action of the General Land Office after final proof has been made.

14. What has your cultivated land cost you per acre? This to include cost of proving-up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—See answers to previous questions.

15. What is its present market value per acre?—Probably it could not be sold for more than $10 per acre, on an average.

16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No crop can be raised without irrigation.

17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—I do not think the present land laws are well adapted to this Territory. My opinion is that if the land, like the water in the streams, was under the control of the Territory or State much more satisfactory results would be obtained, as under the present existing conditions they do not work harmoniously, and large irrigating enterprises suffer a great deal of injustice, and the progress of the settlement of the lands and the development of the resources of the Territory are retarded.

18. What should be done with grazing land which cannot be irrigated? What is its value per acre?—I would suggest that the lands of that nature should be sold to parties having irrigable lands contiguous thereto for grazing purposes. I estimate their value at from 25 cents to $1.50 per acre, according to their grazing qualities, location, and water facilities for stock.

19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—I regard that such action would be detrimental to the progress of the Territory, as it would practically prevent the settlement of all agricultural lands and put a stop to further irrigation enterprises.

20. Do you favor the donation of all irrigable public land to the Territory?—I would recommend that all agricultural and grazing lands be donated by the General Government to the Territory.

Name, JOHN A. FISHER; county, Albany; post-office, Laramie City.

1. How long have you resided in the Territory?—Nineteen years.
2. In what year did you begin farming?—I am not farming as yet.
3. How much land have you under ditch?—About 1,200 acres.
4. If obtained from the Government, state the filings which were made.—One-half section desert, part of a school section, and one-half section railroad land.
5. How many acres are now under cultivation?—[See answer to question 2 above.]
6. By what ditch or ditches is it watered?—By the Fisher ditch.
7. From what stream or streams is water taken?—From the Big Laramie River.
8. Give history of construction of ditch:

(*a*) Names of owners?—John A. Fisher.

(*b*) Date begun and time occupied in building?—It was begun in the month of May, 1884.

(*c*) Dimensions: length, miles, 75; depth, 2 feet; width, 9 feet.

(*d*) How many acres does it water?—Twelve hundred acres.

(*e*) What was the cost of construction?—About $5,000.

(*f*) What is the cost per year for management and repairs?—About $50.

9. Do you buy or sell water; if so, state price paid or received.—I do not.
10. Have you all the water needed; if not, state the reason.—I have.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Don't know as yet.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—I can't tell.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—I have not proved up as yet.
14. What has your cultivated land cost you per acre? This is to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—[No answer.]
15. What is its present market value per acre?—[No answer.]
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—[No answer.]
18. What should be done with grazing land which cannot be irrigated? What is its value per acre?—[No answer.]
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—I do not believe in it.
20. Do you favor the donation of all irrigable public land to the Territory?—I do.

Name, LUKE VOORHEES; county, Laramie; post-office, Cheyenne.

1. How long have you resided in the Territory?—Fifteen years.
2. In what year did you begin farming?—1878 in a small way.
3. How much land have you under ditch?—About 4,000 acres.
4. If obtained from the Government, state the filings which were made.—Luke Voorhees, desert 640, October 10, 1880; George M. Drake, desert, September 15, 1880; George D. Jenks, desert 280, May 24, 1880; Florence L. Voorhees, desert 600, November 5, 1882; Am. Jenks, desert 640, June 19, 1883; William Jenks, desert 640, June 19, 1883; J. G. Huling, pre-emption 160, January 2, 1885; A. G. Lourey, pre-emption, November, 1883, 160.
5. How many acres are now under cultivation?—About 4,000 acres in hay land and other crops.
6. By what ditch or ditches is it watered—L. Z. ditch and Voorhees ditch.
7. From what stream or streams is water taken?—L. Z. ditch, Rawhide Creek; Voorhees, Niobrara Creek.
8. Give history of construction of ditch.—Commencement of ditches were in 1880, completed 1883.

(*a*) Names of owners, Luke Voorhees & Company.

(*b*) Date begun and time occupied in building?—1880, about three years in completing.

(*c*) Dimensions.—Voorhees, 4 feet on top, 3.6 on bottom; length, miles, 6½; depth, 2 feet average; width, 5.4 feet top, 3.6 bottom.

(*d*) How many acres does it water?—Four thousand acres.

(*e*) What was the cost of construction?—About——

(*f*) What is the cost per year for management and repairs?—Am not able to state now.

9. Do you buy or sell water;. if so, state price paid or received.—Neither buy nor sell.
10. Have you all the water needed; if not, state the reasons.—Have sufficient water except in some very dry seasons.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—From $7 to $25.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—One to three years.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered state what they were.—From six months to three years in proving up. The usual difficulties of constructing ditches and other labor.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements?—About $23 per acre.
15. What is its present market value per acre?—Under the rulings of land commissioner for the five years from 1884 to the present time I can hardly say, as it has a market value, no titles.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—Can raise no crop without irrigation.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—I can suggest no changes to the land laws that were passed prior to 1881. It is the rulings of land commissioners that are dangerous to settle.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—On an average not to exceed 10 cents per acre; should be donated to the State or Territory for schools and public buildings.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—I regard it as very dangerous and detrimental to the best interests of the citizens and Territory in general.
20. Do you favor the donation of all irrigable public land to the Territory?—I do. I believe it would be better for the General Government to donate to State or Territory.

Name, BENJ. F. LOWE; county, Fremont; postoffice, Lander.

1. How long have you resided in the Territory?—Twenty-one years.
2. In what year did you begin farming?—1870.
3. How much land have you under ditch?—Thirty acres.
4. If obtained from the Government, state the filings which were made.—Cash entry for N.E. ¼, Sec. 18, Town. 33, Range 99 west Sixth principal meridian.
5. How many acres are now under cultivation?—About 30.
6. By what ditch or ditches is it watered?—By two ditches taken out of the Big Popoagie.

7. From what stream or streams is water taken?—The Big Popoagie River.
8. Give history of construction of ditch.—Were made by me in the year 1875.
(*a*) Names of owners.—Self.
(*b*) Date begun and time occupied in building.—Three or four days.
(*c*) Dimensions, 150 inches; length, one-half mile; depth, 10 inches; width, 18 inches.
(*d*) How many acres does it water?—Ten.
(*e*) What was the cost of construction?—Twenty dollars.
(*f*) What is the cost per year for management and repairs?—One dollar.
9. Do you buy or sell water; if so, state price paid on received.—Sell no water; buy none.
10. Have you all the water needed; if not, state the reason.—No; the Lander Mill Company has taken the water from its proper channel for their own use.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—About $10 per acre.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—Good as ever first year.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—About $600. The town of Lander is located on N.E. ¼, Sec. 18. There were some persons other than myself living on the land, hence some additional cost. Time in obtaining title, sixteen months.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—About $2,000; 160 acres.
15. What is its present market value per acre?—From $50 to $500.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—Some of the bottom land on the streams of Big Popoagie will produce average crop without irrigation; 95 per cent. of Wyoming requires water, more or less.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—The laws are all that could be asked as regards homesteads and desert entries; tree culture is a failure.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—They might be leased by stockmen; artesian wells put down at great expense would bring the lands up to a rate that would re-imburse the State.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—Do not think it necessary; new settlers will not be in the way.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, JOHN O. D. O'BRIEN; county, Converse; post-office, Douglas.
1. How long have you resided in the Territory?—Twenty-two years.
2. In what year did you begin farming?—1877.
3. How much land have you under ditch?—About 80 acres.
4. If obtained from the Government, state the filings which were made.—No filings made on account of Government survey of Fetterman Reservation, includes my claim, and no filing can be made until act of Congress is carried out.
5. How many acres are now under cultivation?—Fifteen acres.
6. By what ditch or ditches is it watered?—O'Brien's Ditch.
7. From what stream or streams is water taken?—La Prele Creek.
8. Give history of construction of ditch:
(*a*) Names of owners. O'Brien & Wallace, Burt Elder, and W. H. Powell.
(*b*) Date begun and time occupied in building.—November 11, 1887. One month.
(*c*) Dimensions, 4 feet; length, 3 miles; depth, 1 foot; width, 4 feet.
(*d*) How many acres does it water?—Two hundred and forty.
(*e*) What was the cost of construction?—About $1,000.
(*f*) What is the cost per year for management and repairs?—Forty to fifty dollars.
9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not state the reason?—Yes.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Ten dollars per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three years.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were?—Congress passed an act to sell the reservation of Fetterman, except what land was occupied by settlers, January 1, 1884, but it seems we are no nearer to-day to file than we were five years ago.

14. What has your cultivated land cost you per acre? This to include cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Ten dollars per acre.
15. What is its present market value per acre?—Nothing until patent is obtained, to which I should have been entitled at least eleven years ago.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—No; an extra grant of, say, 160 acres of hilly land for pasture of grangers' cattle adjoining creek bottoms.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Answered in question 17. Could not say; but very little.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—I hardly understand the question, but am not in favor of any public land being withdrawn, for it hinders settlement.
20. Do you favor the donation of all irrigable public land to the Territory?—No; the United States land laws are good enough for me.

Name, T. M. HERRICK; county, Laramie; post-office, Goshen.
1. How long have you resided in the Territory?—Fourteen years.
2. In what year did you begin farming?—1885.
3. How much land have you under ditch?—Four hundred and fifty acres.
4. If obtained from the Government, state the filings which were made.—Desert.
5. How many acres are now under cultivation?—Two hundred in hay; forty plowed.
6. By what ditch or ditches is it watered?—Spy and Herrick and Bolcom.
7. From what stream or streams is water taken?—Big Horse Creek.
8. Give history of construction of ditch:
(*a*) Names of owners.—T. M. Herrick and wife.
(*b*) Date begun and time occupied in building.—Spy ditch, March, 1885; five months.
(*c*) Dimensions, Spy ditch, length, 1¼ miles; depth, 1 foot; width, 5 feet.
(*d*) How many acres does it water?—Three hundred.
(*e*) What was the cost of construction?—Eight hundred dollars.
(*f*) What is the cost per year for management and repairs?—Twenty-five dollars.
9. Do you buy or sell water? If so, state price paid or received.—In the Spy Ditch, no.
10. Have you all the water needed. If not, state the reason.—Because the water is taken out above me.
11. What is the usual cost of bringing wild land under cultivation; this to include plowing, grubbing sage brush, fencing, etc.?—Some $1; some $5.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—Two.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were.—Four dollars per acre; two years.
14. What has your cultivated land cost you per acre; this to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements?—Six dollars.
15. What is its present market value per acre?—Nothing.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—All but pre-emption and timber claims; they ought to be repealed.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Sold in 1,000-acre lots; 50 cents per acre.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—It would ruin the Territory for the time continued.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, CALEB M. LA GRANGE; county, Laramie; post-office, Goshen.
1. How long have you resided in the Territory?—Twenty-two years.
2. In what year did you begin farming?—1871.
3. How much land have you under ditch?—Eight hundred acres.
4. If obtained from the Government, state the filings which were made.—Under the desert land laws.

5. How many acres are now under cultivation?—Six hundred.
6. By what ditch or ditches is it watered?—Brown & La Grange Ditch.
7. From what stream or streams is water taken.—Horse Creek.
8. Give history of construction of ditch:
(*a*) Name of owners.—D. E. Brown, C. M. La Grange.
(*b*) Date begun and time occupied in building.—March 23, 1883; one year.
(*c*) Dimensions; length 4 miles; North Fork 2 miles; depth, 2 feet; width 13 feet on top and 6 feet on bottom.
(*d*) How many acres does it water?—Twenty-three hundred.
(*e*) What was the cost of construction?—Main ditch, $1,600; my own laterals $300.
(*f*) What is the cost per year for management and repairs?—$150.
9. Do you buy or sell water? If so, state price paid or received.—Do not buy or sell.
10. Have you all the water needed? If not, state the reason.—Have not; water taken by other ditches above.
11. What is the usual cost of bringing wild land under cultivation; this to include plowing, grubbing sage brush, fencing, etc.?—Four dollars.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—Two.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—Made proof in two years and six months after filing; cost $1,200.
14. What has your cultivated land cost you per acre; this to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing and all permanent improvements?—6\frac{775}{800}$.
15. What is its present market value per acre?—From $5 to to $15.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—Free gift of 320 acres to every man or woman that will live on it for five years.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Fifty cents. It should be sold to highest bidder, section at a time.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—It would act on the Territory like a wet blanket on a buffalo-chip fire.
20. Do you favor the donation of all irrigable public land to the Territory?—On condition, no.

Name, LIONEL SARATORIS; county, Albany; post-office, Laramie; manager of the Douglass, Willar and Saratoris Company.

1. How long have you resided in the Territory?—Seven years.
2. In what year did you begin farming?—1887.
3. How much land have you under ditch?—Twelve thousand acres irrigated, 25,000 acres under ditches not irrigated through scarcity of water.
4. If obtained from the Government, state the filings which were made?—About 8,000 obtained from Government, balance railroad land.
5. How many acres are now under cultivation?—Five hundred and fifty acres in oats and other grains, 800 acres in timothy hay, 3,000 native hay, balance of irrigated land as pasture.
6. By what ditch or ditches is it watered?—Snake Ditch and Taback Ditch and Sernatatle Snake Ditch.
7. From what stream or streams is water taken?—Little Laramie, Big Laramie, Mill and Dutton Creeks.
8. Give history of construction of ditch:
(*a*) Names of owners—Douglas, Willar, and Saratoris Company.
(*b*) Date begun and time occupied in building?—Snake Ditch, 1886; Taback Ditch, 1888.
(*c*) Dimensions: 6 miles, 14 miles; depth, 3 feet, 3½ feet; width, 8 feet, 12 feet.
(*d*) How many acres does it water?—See question 3.
(*e*) What was the cost of construction?—Taback $1,200 per mile, Snake $675.
(*f*) What is the cost per year for management and repairs?—About 3 per cent. original cost first year, afterwards 1 per cent.
9. Do you buy or sell water? If so, state price paid or received.—[No answer.]
10. Have you all the water needed? If not, state the reason.—Not for the last two years, on account of mild winters, when there is no snow on the mountains.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—One hundred and twenty-five dol-

lars per mile. I have never grubbed sage-brush, as I have so much good land without any that it does not pay to grub the land.

12. How many years' cultivation are required to bring wild land into proper condition for farming?—Two years.

13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were.—Three dollars and fifty cents per acre to $4.50. Two years in most cases. No difficulties except gross ignorance on the part of the Cheyenne land office.

14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—A very hard question. I answer, about $9 to $15 per acre.

15. What is its present market value per acre?—I consider good meadow $15 per acre, cultivated land $35 per acre, with crop on land.

16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—I am confident that crops can be raised without irrigation if land is plowed and allowed to fallow for one year, then to sow some quick-growing crop. Have it all so as to collect snow, and thus permanently loosen up the subsoil.

17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—All laws are satisfactory, but I think that people who control a large amount of land should be allowed to take up in some several sections of high land for purposes of pasture. I mean lands that are impossible to irrigate and that the "honest settler" has no use for. This will be better than the present unsatisfactory conditions of Government uplands. This quality of land is of no value except to large land-owners who have many cattle, and they should be allowed to control it either by lease or sale. These lands have always been the great impediment to Eastern capital coming into this Territory.

19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—I see no use for doing this.

20. Do you favor the donation of all irrigable public land to the Territory?—Yes; as long as the Territory is not allowed to put exorbitant prices on the uplands they should still in some way be controlled by Government, and county commissioners should have nothing to say in the matter of selling or trading these lands.

Name, JOHN R. SMITH; county, Johnson; post-office, Traburg.

1. How long have you been in the Territory?—Twenty-three years.

2. In what year did you begin farming?—1879.

3. How much land have you under ditch?—One thousand two hundred acres.

4. If obtained from the Government, state the filings which were made.—One homestead, one timber culture, two desert claims.

5. How many acres are now under cultivation?—About 800—400 pasture.

6. By what ditch or ditches is it watered?—The John R. Smith Ditch.

7. From what stream or streams is water taken?—Crazy Woman's Fork of Powder.

8. Give history of construction of ditch:

(*a*) Names of owners, John R. Smith, Agnes Smith.

(*b*) Date begun and time occupied in building?—10th day of April, 1879.

(*c*) Dimensions: Length, 6 miles; depth, 2 feet; width, 7 feet.

(*d*) How many acres does it water?—Ten thousand.

(*e*) What was the cost of construction?—Six hundred dollars.

(*f*) What is the cost per year for management and repairs?—On average, $75.

9. Do you buy or sell water? If so, state price paid or received.—[No answer.]

10. Have you all the water needed? If not, state the reason.—I have not this year; and 1886 and 1887 was short, caused by other ditches using it.

11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage-brush, fencing, etc.—Mine has cost me about $850, not including Government cost.

12. How many years' cultivation are required to bring wild land into proper condition for farming?—Two years.

13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were.—One thousand dollars on 40 acres; $350 on 240 acres; and $20 on 160; timber culture, not proved upon, 160 acres; three years and five years.

14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Thirteen thousand and eighty-five dollars, in full.

15. What is its present market value per acre?—There is no land selling at any price.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—You can not raise anything here without water to irrigate with.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest.—I do not think the Territory should own and control her own lands.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Five to 20 cents per acre, sold to any one wishing to purchase.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—It will be an injustice to the public.
20. Do you favor the donation of all irrigable public land to the Territory?—I do; strongly.

Name, GUSTAVE E. A. MOELER; county, Johnson; post-office, Buffalo.
1. How long have you resided in the Territory?—Twelve years.
2. In what year did you begin farming?—1879.
3. How much land have you under ditch?—One thousand two hundred and eighty acres.
4. If obtained from the Government, state the filings which were made?—Homestead, pre-emption, and two desert filings.
5. How many acres are now under cultivation?—About 800.
6. By what ditch or ditches is it watered?—North Fork and French Creek Ditch Company's ditch.
7. From what stream or streams is water taken?—North Fork of Clear Creek.
8. Give history of construction of ditch:
(*a*) Names of owners, North Fork and French Creek Ditch Company (a corporation).
(*b*) Date begun and time occupied in building?—January 3, 1886; five months.
(*c*) Dimensions, 112 square feet per section; length, 2 miles; depth, 3 feet; width, 7 feet.
(*d*) How many acres does it water?—Three thousand.
(*e*) What was the cost of construction?—Two thousand dollars.
(*f*) What is the cost per year for management and repairs?—Two hundred dollars.
9. Do you buy or sell water? If so, state price paid or received.—[No answer.]
10. Have you all the water needed? If not, state the reason—I have.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage-brush, fencing, etc.—The cost to me has been about $12 per acre.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—Three years.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—I paid the United States $1.25 per acre for 1,120 acres. It took nine years to get title to my homestead; six years for my desert. For 800 acres I have no title yet, although final proof has been made.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Answered above.
15. What is its present market value per acre?—Ten to twelve dollars.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—Not a spear of grass long enough to cut with a mower.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—I have none to suggest. Desert law ought not to be repealed.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Might be sold without restriction as to quantity salable to one man. About 50 cents to $1.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—Might be a good plan to head off speculators.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, JOHN DARBIN; county, Carbon; post-office, Darbin.
1. How long have you resided in the Territory?—Twenty-one years.
2. In what year did you begin farming?—1875.
3. How much land have you under ditch?—The company in which I am interested has 400 acres.

4. If obtained from the Government, state the filings which were made?—Desert claim.
5. How many acres are now under cultivation?—One hundred.
6. By what ditch or ditches is it watered?—Darbin Nos. 1, 2, and 3.
7. From what stream or streams is water taken?—Muddy Creek.
8. Give history of construction of ditch:
(*a*) Name of owners, Darbin Cattle Company or Union Darbin Company.
(*b*) Date begun and time occupied in building?—[No answer.]
(*c*) Dimensions: Length, east, 2½ to 3 miles; depth, No. 1, 2 feet; No. 2, 2 feet; No. 3, 2 feet; width, No. 1, 5 feet; No. 2, 4 feet; No. 3, 4 feet.
(*d*) How many acres does it water?—Four hundred acres.
(*e*) What was the cost of construction?—Two thousand dollars.
(*f*) What is the cost per year for management and repairs?—Fifty dollars.
9. Do you buy or sell water. If so, state price paid or received.—Neither buy nor sell.
10. Have you all the water needed? If not, state the reason.—Have not. Failure of stream in summer is the cause.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage-brush, fencing, etc.—Eight to twelve dollars. Planting and grubbing sage-brush is alone worth $8 per acre.
12. How many years' cultivation are required to bring wild land into proper condition for farming?—Three to five years.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—It was hard work to get the ditches completed within three years. The expense of getting witnesses to Cheyenne was also heavy.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Fifteen dollars.
15. What is its present market value per acre?—[No answer.]
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—Can not raise anything.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what change would you suggest?—More time should be given on the desert land proofs.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—I hardly know as to the first. Its value does not exceed 5 cents per acre.
19. How do you regard the withdrawal of all public land from settlement during the Irrigation Survey?—It would be detrimental.
20. Do you favor the donation of all irrigable public land to the Territory?—[No answer.]

Name, JOHN H. GORDON; county, Laramie; post-office, Little Horse Creek.
1. How long have you resided in the Territory?—Twelve years.
2. In what year did you begin farming?—1871, in Colorado.
3. How much land have you under ditch?—About 1,400 acres.
4. If obtained from the Government, state the filings which were made?—Most of the land I obtained by purchase which was taken up under the pre-emption, homestead, and desert act.
5. How many acres are now under cultivation?—About 1,000 acres.
6. By what ditch or ditches is it watered?—These lands are watered by nine ditches.
7. From what stream or streams is water taken?—Little Horse Creek Mills, Herrick Creeks, Mills Creek Ditch No. 1, and No. 2, and No. 3.
8. Give history of construction of ditch:
(*a*) Names of owners, Springdale Ditch Company, Herrick ditches No. 1 and No. 2.
(*b*) Date begun and time occupied in building?—The oldest, 1873; the balance since that time.
(*c*) Dimensions, from 2 to 8 feet wide; length, 1 to 5 miles; depth, about 18 inches; width, 2 to 8 feet wide.
(*d*) How many acres does it water?—About 1,000 acres.
(*e*) What was the cost of construction?—In the neighborhood of $7,000.
(*f*) What is the cost per year for management and repairs?—About $400.
9. Do you buy or sell water; if so, state price paid or received?—I neither buy nor sell water for the above lands.
10. Have you all the water needed? If not, state the reason.—No; the waters in this section not adjudicated yet.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage-brush, fencing, etc.—From $15 to $20 per acre.

12. How many years' cultivation are required to bring wild land into proper condition for farming?—Three years.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were.—As I said before, I purchased most of the above lands.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—About $20 per acre.
15. What is its present market value per acre?—About $15 per acre.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—No; I should think the Territory ought to be allowed to make laws to govern the settlement of her lands.
18. What should be done with grazing land which cannot be irrigated? What is its value per acre?—It should be left as a common; but there is very little land which can not be irrigated.
19. How do you regard the withdrawal of all irrigable public land from settlement during the Irrigation Survey?—I think it would be a calamity to the Territory.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, D. E. BROWN; county, Laramie; post-office, Goshen.
1. How long have you resided in the Territory?—Fifteen years.
2. In what year did you begin farming?—1885.
3. How much land have you under ditch?—About 1,400 acres.
4. If obtained from the Government, state the filings which were made?—Two desert, homestead, and tree claim.
5. How many acres are now under cultivation?—One hundred under plow.
6. By what ditch or ditches is it watered?—By Brown and La Grange ditches.
7. From what stream or streams is water taken?—Big Horse Creek.
8. Give history of construction of ditch:
(*a*) Name of owners—D. E. Brown and C. M. La Grange.
(*b*) Date begun and time occupied in building?—March, 1883; two years.
(*c*) Dimensions, 13 by 6 by 2; length, about 6 miles; depth, 2 feet; width, top 13 feet, bottom 6 feet.
(*d*) How many acres does it water?—About 1,800.
(*e*) What was the cost of construction?—My interest $2,000, on main line.
(*f*) What is the cost per year for management and repairs?—One hundred dollars will cover all repairs.
9. Do you buy or sell water? If so, state price paid or received.—No.
10. Have you all the water needed? If not, state the reason.—At all times, not. Because the water is used above us in the newer ditches that have been infringing on our priority of right.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—From $4 to $5 per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—For small grains, etc., just as soon as ditches are completed, with water ready for use.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties where encountered, state what they were.—The land cost me from the Government, including all expense in making final proof, about $1.50 per acre.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing and all permanent improvements.—Nine dollars per acre.
15. What is the present market value per acre?—I value it at $15 per acre.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—We can not raise crops without irrigation.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—I would suggest four years for making final proof on desert entries and that homesteaders be allowed 320 acres where they prove five years' continuous residence.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Fifty cents per acre. I would favor its being leased subject to settlement.
19. How do you regard the withdrawal of all irrigable public land from settlement during the Irrigation Survey?—I do not approve of the withdrawal of all public lands during survey, only in sections where they are commencing to operate.
20. Do you favor the donation of all irrigable public land to the Territory?—On certain conditions, I do.

Name, A. M. McLAUGHTIN; county, Laramie; post-office, Davis Ranch.

1. How long have you resided in the Territory?—Twelve years.
2. In what year did you begin farming?—1878.
3. How much land have you under ditch?—One hundred acres.
4. If obtained from the Government, state the filings which were made?—Homestead entry.
5. How many acres are now under cultivation?—One hundred.
6. By what ditch or ditches is it watered?—McLaughtin, Nos. 1, 2, and 6.
7. From what stream or streams is water taken?—North Horse Creek.
8. Give history of construction of ditch:

(*a*) Names of owners. A. and J. McLaughtin.
(*b*) Date begun and time occupied in building?—1874.
(*c*) Dimensions. Length, 2½ miles; depth, 15 inches; width, 2½ to 3 feet.
(*d*) How many acres does it water?—One hundred and sixty.
(*e*) What was the cost of construction?—One thousand dollars.
(*f*) What is the cost per year for management and repairs?—One hundred dollars.

9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not, state the reason?—Used to have water enough, but now failing on account of dry weather.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Eight to ten dollars per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three years.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—Five years time and cost of $1.25 per acre.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing and all permanent improvements.—Twenty-two dollars per acre.
15. What is its present market value per acre?—Fifteen dollars per acre.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—Government should give each man one section of land in fee simple, when he has reclaimed the same.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Sell it in limited tracts at from 8 to 12 cents per acre.
19. How do you regard the withdrawal of all irrigable public land from settlement during the irrigation survey?—It would stop all settlement of the Territory.
20. Do you favor the donation of all irrigable public land to the Territory?—[No answer.]

Name, EMMA M. LATHAN; county, Laramie; post-office, Davis Ranch.

1. How long have you resided in the Territory?—Eighteen years.
2. In what year did you begin farming?—1873.
3. How much land have you under ditch?—Eighty acres.
4. If obtained from the Government, state the filings which were made.—Preemption.
5. How many acres are now under cultivation?—Eighty.
6. By what ditch or ditches is it watered?—Ditch not named.
7. From what stream or streams is water taken?—Spring Creek, a branch of Horse Creek.
8. Give history of construction of ditch:

(*a*) Names of owners.—Emma M. Lathan.
(*b*) Date begun and time occupied in building?—1879; about three years.
(*c*) Dimensions.—Length, 1 mile; depth, 8 inches; width, 3 feet.
(*d*) How many acres does it water?—Eighty.
(*e*) What was the cost of construction?—Two hundred and fifty dollars.
(*f*) What is the cost per year for management and repairs?—Fifty dollars.

9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not, state the reason?—No. Water was not in the creek.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—From $7 to $10.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Two to four years.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they

were.—Two dollars and twenty-five cents, and took about three years. A mistake of date was made by the land office and I had to offer proof a second time.

14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Sixteen to twenty dollars.

15. What is its present market value per acre?—About $15.

16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.

17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—I do not know, but I think every settler should have one section of land for reclaiming it.

18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Should be sold at auction or at fixed value; 10 to 25 cents per acre.

19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—Unfavorably, for it would stop the settlement of the Territory.

20. Do you favor the donation of all irrigable public lands to the Territory?—I do.

Name, T. W. RUTLEDGE; county, Laramie; post-office, Little Horse Creek.

1. How long have you resided in the Territory?—Twenty-two years.
2. In what year did you begin farming?—18-3.
3. How much land have you under ditch?—Four thousand eight hundred acres.
4. If obtained from the Government, state the filings which were made?—Homestead, timber-culture, and mostly desert entries.
5. How many acres are now under cultivation?—One hundred and fifty plowed; 2,000 to hay.
6. By what ditch or ditches is it watered?—Rutledge and Hellman Ditch.
7. From what stream or streams is water taken?—Horse Creek.
8. Give history of construction of ditch:

(*a*) Names of owners.—Rutledge and Hellman.

(*b*) Date begun, and time occupied in building.—1883; and was three years in building.

(*c*) Dimensions.—Length, 50 miles; depth, 4 feet to 1 foot; width, 17 feet to 3 feet.

(*d*) How many acres does it water?—Three hundred acres really watered this year, 1889.

(*e*) What was the cost of construction?—Thirty thousand dollars.

(*f*) What is the cost per year for management and repairs?—One thousand dollars.

9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not, state the reason?—No, the last three seasons have been uncommonly dry, and we have no way of holding the water in time of a freshet.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Seven dollars and fifty cents per acre. No grubbing is necessary.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three to five years.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were.—One dollar and twenty-five cents for land, and $2.00 for each of the six entrymen on the land.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Fifteen dollars per acre.
15. What is its present market value per acre?—Twenty-two dollars per acre, but can not sell for $12.
16. Can you raise crops without irrigation? If so, state what they are, and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—No; any man that reclaims a section of land should have a free title, and be exempt from taxes for five years.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Hold it as a public range; value, 25 cents per acre.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—As extremely detrimental to the Territory.
20. Do you favor the donation of all irrigable public land to the Territory?—I do.

Name, JNO. MCLAUGHLIN; county, Laramie; post-office, Davis Ranch.

1. How long have you resided in the Territory?—Twelve years.
2. In what year did you begin farming?—1878.
3. How much land have you under ditch?—Two hundred and forty acres.
4. If obtained from the Government, state the filings which were made?—Desert entry.
5. How many acres are now under cultivation?—Two hundred and forty acres.
6. By what ditch or ditches is it watered?—McLaughlin ditch, No. 5.
7. From what stream or streams is water taken?—North Horse Creek.
8. Give history of construction of ditch:

(*a*) Names of owners.—A. and J. McLaughlin.

(*b*) Date begun and time occupied in building?—1874; by Mr. Sanders, about eleven years.

(*c*) Dimensions. Length, 3½ miles; depth; 1½ feet; width, 5 feet.

(*d*) How many acres does it water?—Six hundred.

(*e*) What was the cost of construction?—One thousand seven hundred dollars.

(*f*) What is the cost per year for management and repairs?—One hundred dollars.

9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not, state the reason?—Not for the last two seasons, as they have been exceedingly dry.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Eight dollars to ten dollars per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three years.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were.—Three years time, at a cost of about $2.50 per acre.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing and all permanent improvements. Fourteen dollars to fifteen dollars per acre.
15. What is its present market value per acre?—Ten dollars.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—Any man that reclaims a section of land should have it in fee simple.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Should be sold at 10 cents per acre, and no man or company to have over one section.
19. How do you regard the withdrawal of all irrigable public land from settlement during the irrigation survey?—I think it would stop the settlement of the country.
20. Do you favor the donation of all irrigable public land to the Territory?—[No answer.]

Name, LIZZIE D. JOHNSTON; county, Laramie; post-office, Little Horse Creek.

1. How long have you resided in the Territory?—Eight years.
2. In what year did you begin farming?—1881.
3. How much land have you under ditch?—Two hundred and forty acres.
4. If obtained from the Government, state the filings which were made?—Desert entry.
5. How many acres are now under cultivation?—About 200 acres.
6. By what ditch or ditches is it watered?—Johnston Ditch, No. 1.
7. From what stream or streams is water taken?—Little Horse Creek.
8. Give history of construction of ditch:

(*a*) Names of owners.—J. R. Johnston, Lizzie D. Johnston, Geo. D. Johnston.

(*b*) Date begun and time occupied in building?—Commenced 1882; about one year.

(*c*) Dimensions.—Length, 3½ miles; depth, 18 inches; width, 3½ feet.

(*d*) How many acres does it water?—About 1,000 acres.

(*e*) What was the cost of construction?—About $3,000.

(*f*) What is the cost per year for managment and repairs?—Two hundred and dollars.

9. Do you buy or sell water. If so, state price paid or received.—No.
10. Have you all the water needed? If not, state the reason.—All that is needed.
11. What is the usual cost of bringing wild land under cultivation?—This to include plowing, grubbing sage brush, fencing. etc.—From $8 to $10.
12. How many years cultivation are required to bring wild land into proper condition for farming?—From one to four years.

13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—Not less than $2 per acre. No difficulties, as I had fully complied with the law.

14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing and all permanent improvements.—Ten dollars.

15. What is its present market value per acre?—Not over $3 per acre.

16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.

17 Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—[No answer.]

18. What should be done with grazing land which can not be irrigated? What is its value per acre?—I do not know.

19. How do you regard the withdrawal of all irrigable public land from settlement during the irrigation survey?—Very unfavorably.

20. Do you favor the donation of all irrigable public land to the Territory?—No.

Name, DONALD CLARK; county, Laramie; post-office, Davis Ranch.

1. How long have you resided in the Territory?—Fifteen years.

2. In what year did you begin farming?—1874.

3. How much land have you under ditch?—One hundred acres.

4. If obtained from the Government, state the filings which were made?—Homestead.

5. How many acres are now under cultivation?—One hundred acres.

6. By what ditch or ditches is it watered?—Horse Creek Ditch, No. 8.

7. From what stream or streams is water taken?—Main fork of Horse Creek.

8. Give history of construction of ditch:

(*a*) Names of owners.—Donald Clark and Cheyenne Land and Live-stock Company.

(*b*) Date begun and time occupied in building?—1875; about two years.

(*c*) Dimensions.—Length, 2½ miles; depth, 1 foot; width, 3 feet.

(*d*) How many acres does it water?—One hundred.

(*e*) What was the cost of construction?—Five hundred dollars.

(*f*) What is the cost per year for management and repairs?—Seventy-five dollars.

9. Do you buy or sell water? If so, state price paid or received.—No.

10. Have you all the water needed; if not, state the reason?—Some seasons there is plenty, but the last two have been short on account of drought.

11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—From $10 to $12 per acre.

12. How many years cultivation are required to bring wild land into proper condition for farming?—Four years.

13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—Cost about $1 per acre and five years time.

14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Not less than $14.

15. What is its present market value per acre?—From $8 to $10.

16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.

17. Do you think the present land laws are adapted to the conditions of this Territory; if not, what changes would you suggest?—I do not know.

18. What should be done with grazing land which can not be irrigated? What is its value per acre?—From 10 to 25 cents per acre and limit the amount that each actual occupant shall be allowed to purchase not to exceed one section.

19. How do you regard the withdrawal of all irrigable public land from settlement during the irrigation survey?—Very unfavorably.

20. Do you favor the donation of all irrigable public land to the Territory?—I do.

Name, R. P. MULL; county of Laramie; post-office, Davis Ranch.

1. How long have you resided in the Territory?—Twenty years.

2. In what year did you begin farming?—1878.

3. How much land have you under ditch?—One hundred and twenty-five acres.

4. If obtained from the Government, state the filings which were made.—Homestead.

5. How many acres are now under cultivation?—One hundred and twenty-five.
6. By what ditch or ditches is it watered?—Mull Ditch, No. 1.
7. From what stream or streams is water taken?—Horse Creek.
8. Give history of construction of ditch:
(*a*) Names of owners.—B. P. and Mary Mull.
(*b*) Date begun and time occupied in building?—1879; three years.
(*c*) Dimensions; length?—1¼ miles; depth, 1 foot; width, 4½ feet.
(*d*) How many acres does it water?—One hundred and twenty-five.
(*e*) What was the cost of construction?—One thousand dollars.
(*f*) What is the cost per year for management and repairs?—One hundred dollars.
9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not, state the reason?—No; where my dam is there is so much sand that the water runs underground.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.?—Nine dollars per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Four to seven years.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were?—Twelve dollars per acre.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Thirty-two dollars per acre.
15. What is its present market value per acre?—Twenty dollars per acre.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—No.
17. Do you think the present land laws are adapted to the conditions of this Territory; if not, what changes would you suggest?—No; every citizen that reclaims the land should have, in fee simple, a title to one section of land.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Should be sold at 8 to 10 cents per acre, and each person to have not over two sections.
19. How do you regard the withdrawal of all irrigable public land from settlement during the irrigation survey?—Unfavorably, as it would stop all settlement of the Territory.
20. Do you favor the donation of all irrigable public land to the Territory?—I do.

Name, AUGUSTUS TRABING; county, Albany; post-office, Laramie.
1. How long have you resided in the Territory?—Twenty-one years.
2. In what year did you begin farming?—1886.
3. How much land have you under ditch?—Sold out; had 800 acres.
4. If obtained from the Government, state the filings which were made?—I bought it from the Wyoming Central Land and Improvement Company.
5. How many acres are now under cultivation?—Twenty acres. Rest in grass.
6. By what ditch or ditches is it watered?—Pioneer Canal.
7. From what stream or streams is water taken?—Big Laramie River.
8. Give history of construction of ditch:
(*a*) Name of owners —Pioneer Canal Company.
(*b*) Date begun and time occupied in building?—Completed in 1886.
(*c*) Dimensions: Length, 35 miles; depth, 4 feet; width, 16 feet.
(*d*) How many acres does it water?—Twenty thousand.
(*e*) What was the cost of construction?—Fifty thousand dollars.
(*f*) What is the cost per year for management and repairs?—Twelve hundred dollars.
9. Do you buy or sell water; if so, state price paid or received?—Buy; 50 cents per acre.
10. Have you all the water needed; if not, state the reason?—Did have.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Five dollars per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered, state what they were?—I paid $10 per acre, as it was only 2 miles from Laramie, Wyo.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements?—Twenty dollars, but I made extensive improvements.

15. What is its present market value per acre?—Sold for $40 last May, with all stock and improvements, net about $30 per acre.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—No. Let each man have a section of desert-land for homestead on reclamation.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Give it to Territory, value about 25 cents.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—A withdrawal for one year is all right.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, C. W. HOLDEN; county, Uinta; post-office; Fontenelle.
1. How long have you resided in the Territory?—Nearly thirteen years.
2. In what year did you begin farming?—1877.
3. How much land have you under ditch?—About 800 acres.
4. If obtained from the Government, state the filings which were made?—Homestead and pre-emption, desert, and timber-culture, also lease of school land.
5. How many acres are now under cultivation?—About 800 acres.
6. By what ditch or ditches is it watered?—Nos. 1, 2, 3, and 4.
7. From what stream or streams is water taken?—Fontenello.
8. Give history of construction of ditch:
(*a*) Names of owners—C. W. Holden.
(*b*) Date begun and time occupied in building?—No. 1 was commenced in 1878.
(*c*) Dimensions: Length, 4 miles; depth, 1 to 2 feet; width, 4 to 6 feet.
(*d*) How many acres does it water?—About 800.
(*e*) What was the cost of construction?—About $1 per rod.
(*f*) What is the cost per year for management and repairs?—Not far from $200.
9. Do you buy or sell water; if so, state price paid or received?—No.
10. Have you all the water needed; if not, state the reason?—Yes. Have had so far.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc?—About $10.
12. How many years cultivation are required to bring wild land into proper condition for farming?—About two.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—My homestead cost two usual fees and about $50 for incidental expenses; have not final proof on the other entries.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Twelve dollars to fifteen dollars.
15. What is its present market value per acre?—Don't know.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—Give the desert land to the man who reclaims and reduces it to cultivation upon final proof that he has done so.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Lands not susceptible of irrigation are of little value for any purpose; after the water-courses are all fenced.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—It would virtually stop immigration and could only benefit wealthy grazers.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, EDWIN C. SMITH; county, Converse; post-office, Douglas.
1. How long have you resided in the Territory?—Since April 4, 1873; sixteen years.
2. In what year did you begin farming?—1881.
3. How much land have you under ditch?—Three hundred and twenty acres.
4. If obtained from the Government, state the filings which were made.—One hundred and sixty homestead, 160 pre-emption.
5. How many acres are now under cultivation?—Thirty plow, 50 hay, balance pasture.

6. By what ditch or ditches is it watered?—My own ditch.
7. From what stream or streams is water taken?—Laprelle Creek.
8. Give history of construction of ditch:
(*a*) Names of owners—First ditch made by Joseph Hornbeck in 1887; I bought and reconstructed it.
(*b*) Date begun and time occupied in building?—1881; have forgotten exact date when finished.
(*c*) Dimensions: Length, 2 miles; depth, 1 foot; width, 5 feet.
(*d*) How many acres does it water?—About 100 acres.
(*e*) What was the cost of construction?—Five hundred dollars.
(*f*) What is the cost per year for management and repairs?—Can't state exactly.
9. Do you buy or sell water; if so, state price paid or received?—Do not sell.
10. Have you all the water needed; if not, state the reason?—Have when ditch is in good order, sometimes have breaks in ditch.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—About $10.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered state what they were.—Distance from land office when filings were made; received every courtesy from officials of land office.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—About $12.
15. What is its present market value per acre?—Can't state, as no sales are being made.
16. Can you raise crops without irrigation; if so, state what they are and yields obtained?—No; sometimes potatoes, but very seldom.
17. Do you think the present land laws are adapted to the conditions of this Territory; if not, what changes would you suggest?—Haven't any suggestion to make; am satisfied with the present land laws.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Leave them, as they are a benefit to the settlers for grazing purposes.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—Favorable; don't exactly understand it.
20. Do you favor the donation of all irrigable public land to the Territory?—Can't say.

Name, A. L. SUTHERLAND; county, Albany; post-office, Sherman.
1. How long have you resided in the Territory?—Eleven years.
2. In what year did you begin farming?—In 1881.
3. How much land have you under ditch?—One hundred and twenty acres.
4. If obtained from the Government, state the filings which were made.—Homestead and also railroad lands.
5. How many acres now under cultivation?—One hundred and thirty-five.
6. By what ditch or ditches is it watered?—Private.
7. From what stream or streams is water taken?—Dale Creek, Pump Creek, and springs.
8. Give history of construction of ditch.—It was begun in 1872, and lengthened from time to time.
(*a*) Name of owner.—A. L. Sutherland.
(*b*) Date begun and time occupied in building.—1872, time of building not known.
(*c*) Dimensions.—Length, 3 miles; depth, 2 feet; width, 3 feet.
(*d*) How many acres does it water?—Forty.
(*e*) What was the cost of construction?—Six hundred dollars.
(*f*) What is the cost per year for management and repairs? [No answer.]
9. Do you buy or sell water. If so, state price paid or received.—Do not sell.
10. Have you all the water needed? If not, state the reason.—Have not, as those who have taken out ditches about me use all there is at times.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Ten dollars.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Two.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—Cost $72.60. Had the best of proof, but patent is delayed over three years. Has not arrived yet.

14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Twelve dollars.
15. What is its present market value per acre?—Twelve dollars.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—Can not.
17. Do you think the present laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—That patents should be issued within six months after final proof.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—One dollar and seventy-five cents. Thrown open to all not fenced in with railroad land.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—I think there should be restrictions on it.
20. Do you favor the donation of all irrigable public land to the territory?—I do.

Name, J. F. ROCHE; county, Laramie; post-office, Wendover.
1. How long have you resided in the Territory?—Three years.
2. In what year did you begin farming?—1886.
3. How much land have you under ditch?—Three hundred acres.
4. If obtained from the Government, state the filings which were made?—Homestead and desert.
5. How many acres are now under cultivation?—Fifty.
6. By what ditch or ditches is it watered?—Jumbo.
7. From what stream or streams is water taken?—Cottonwood Creek.
8. Give history of construction of ditch:
   (*a*) Name of owner.—J. F. Roche.
   (*b*) Date begun and time occupied in building.—September, 1886. Completed in 1887.
   (*c*) Dimensions.—Length, 2½ miles; depth, from 1 to 8 feet; width, 8 feet.
   (*d*) How many acres does it water?—Covers about 300 acres, but water is insufficient.
   (*e*) What was the cost of construction?—Five hundred dollars.
   (*f*) What is the cost per year for management and repairs?—Twenty-five dollars.
9. Do you buy or sell water? If so, state price paid or received.—No.
10. Have you all the water needed? If not, state the reason.—No water in the stream after about July 1.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—Six dollars.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Three years.
13. What did it cost you to prove up and obtain title to your land, and what was the length of time required? If any difficulties were encountered state what they were.—Not proved up.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Six dollars.
15. What is the present market value per acre?—No fixed value.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—Yes; have raised corn, wheat, oats, alfalfa, potatoes, and vegetables.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—No. I should suggest that all lands redeemable by irrigation should be given to parties redeeming the same without the necessary $1.25 per acre.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Should be leased to settlers at nominal figures.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—Do not think it proper.
20. Do you favor the donation of all irrigable public land to the Territory?—Yes.

Name, HAINES BROS.; county, Carbon; post-office, Saratoga.
1. How long have you resided in the Territory?—Six years.
2. In what year did you begin farming?—1883.
3. How much land have you under ditch?—Two thousand five hundred acres

4. If obtained from the Government, state the filings which were made?—Desert and pre-emption filings.
5. How many acres are now under cultivation?—About 250.
6. By what ditch or ditches is it watered?—Haines Ditch and other small ditches.
7. From what stream or streams is water taken?—North and South Spring Creek.
8. Give history of construction of ditch:
(*a*) Names of owners.—J. G. Haines, H. W. Haines, and M. Haines.
(*b*) Date begun and time occupied in building?—May 1, 1885; time, four months.
(*c*) Dimensions.—11 by 8 by 2; length, 11 miles; depth, 2 feet; width, 11 feet. Five miles of this ditch on a grade of 4 feet to the mile is of above dimensions; 3 miles natural water course; balance, owing to heavier grades, smaller.
(*d*) How many acres does it water?—Two thousand.
(*e*) What was the cost of construction?—Four thousand dollars.
(*f*) What is the cost per year for management and repairs?—Fifty dollars.
9. Do you buy or sell water? If so, state price paid or received.—No.
10. Have you all the water needed? If not, state the reason.—During high water have plenty, but last of the season not enough water in creek to fill ditch.
11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.—From $5 to $10 per acre.
12. How many years cultivation are required to bring wild land into proper condition for farming?—Most land a fair crop first year.
13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were.—Cost, $1.25 per acre, with addition of advertising and agents' fees.
14. What has your cultivated land cost you per acre? This to include cost of proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Ten dollars per acre.
15. What is its present market value per acre?—Thirty dollars per acre.
16. Can you raise crops without irrigation? If so, state what they are and yields obtained.—No.
17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—Let them remain as they are.
18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Left open to the public. Varies from nothing up.
19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—Do not regard it favorably.
20. Do you favor the donation of all irrigable public land to the Territory?—No.

Name, ED B. CHAPLIN; county, Johnson; post-office, Buffalo.
1. How long have you resided in the Territory?—At intervals since 1867. Continuously thirteen years.
2. In what year did you begin farming?—In Wyoming in 1879.
3. How much land have you under ditch?—About 200 acres, originally 320 acres.
4. If obtained from the Government, state the filings which were made.—Desert.
5. How many acres are now under cultivation?—One hundred and eighty nearly; garden 20, hay 160.
6. By what ditch or ditches is it watered?—Snider Ditch No's 1 and 2, Four Lakes and French Creek Ditches and Flume Company's.
7. From what stream or streams is water taken?—Clear fork of Powder River and French Creek.
8. Give history of construction of ditch:
(*a*) Names of owners, Snider Ditch No. 1, E. M. Snider and myself; Four Lakes and French Creek O. J. Wastman, R. S. Hopkins, H. R. Mann, F. Meyers, P. Georgen.
(*b*) Date begun and time occupied in building?—Three months; three and a half months.
(*c*) Dimensions: 5 feet, 10 feet; length, 3 miles, 1½ miles; depth, 2 feet, 2½ feet; width, top, 9 feet, top, 15 feet.
(*d*) How many acres does it water?—Seven hundred acres. Don't know how many acres Four Lakes and French Creek Ditch waters, but think about 5,000 acres.
(*e*) What was the cost of construction?—Snider No 1, $600; Four Lakes and French Creek, about $1,000.
(*f*) What is the cost per year for management and repairs?—Snider No. 1, about $50; Four Lakes and French Creek, $350.
9. Do you buy or sell water; if so, state price paid or received?—[No answer.]
10. Have you all the water needed; if not, state the reason?—Have this season *had all the* water needed, but not in former years at times, because it was appropriated by parties above me, who had no right to it.

11. What is the usual cost of bringing wild land under cultivation? This to include plowing, grubbing sage brush, fencing, etc.--Ordinary hay land $12 to $25 per acre, garden $150 approximated.

12. How many years cultivation are required to bring wild land into proper condition for farming?—Three to five.

13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered, state what they were?—Actual cost was $550 to get final receipt. Have not received patent yet, although I proved in May, 1883.

14. What has your cultivated land cost you per acre? This to include proving up, cost of ditches and laterals, expense of preparing land for cultivation, fencing, and all permanent improvements.—Thirty-two dollars and sixty-three cents per acre.

15. What is its present market value per acre?—About $50.

16. Can you raise crops without irrigation? If so, state what they are and yields obtained?—Nothing without water.

17. Do you think the present land laws are adapted to the conditions of this Territory? If not, what changes would you suggest?—[No answer.]

18. What should be done with grazing land which can not be irrigated? What is its value per acre?—Should lease to stockmen. It is very difficult to fix value.

19. How do you regard the withdrawal of all public land from settlement during the irrigation survey?—If the survey does not continue too long lands should be withdrawn to guard against speculation in reservoir sites.

20. Do you favor the donation of all irrigable public land to the Territory?—I do.

Name, CHAS. A. POLLARD, county of Converse; post-office at Labonte.

1. How long have you resided in the Territory?—Twelve years.

2. In what year did you begin farming?—In 1878.

3. How much land have you under ditch?—Six hundred acres.

4. If obtained from the Government, state the filings which were made.—Pre-emption No. 1341, November 10, 1883; settlement made in spring of 1883, 160 acres; desert filing No. 633 in 1883; number of acres proved upon three years afterwards, in summer of 1886, 440 acres.

5. How many acres are now under cultivation?—About 400 acres.

6. By what ditch or ditches is it watered?—By Labonte Road Ranch Ditch No. 1 and Labonte Road Ranch Ditch No. 2.

7. From what stream is water taken?—From the main Labonte Creek.

8. Give history of construction of ditches.—Labonte Road Ranch Ditch No. 1 was begun in 1880 and partly completed and water run through it in the spring of 1883; but the ditch and ditch-head was very unsatisfactory at that time, owing to the fact that none of the excavation was "down to grade" and would only carry water during a "stage of high water." At this juncture my associate and myself purchased the ditch and entire ranch property and all improvements, paying $5,000 in cash for same. The parties we purchased from had made no land entries up to that time, but they were about to do so. Since the date of our purchase in 1883 we have enlarged No. 1 ditch, put it "down to grade," and kept it in constant repair at a very heavy annual cost, and it is now a permanent ditch, as all banks are grass grown.

Labonte Road Ranch Ditch No. 2 was commenced in the fall of 1883 and work has been done constantly upon it up to date, and the ditch has been in operation about one-half the time since the spring of 1885, and it is now in perfect order, but requires constant labor at a heavy expense to keep it in condition.

(*a*) Name of owners—Charles A. Pollard and Sophia E. Pollard.

(*b*) Date begun and time occupied in building—1880 and 1883. All of two years and three years.

(*c*) Dimensions—5 by 2 feet; length, about 12 miles; depth, 2 feet; width, 5 feet on bottom, 8 feet at top.

(*d*) How many acres does it water?—The two ditches will water more than 1,500 acres.

(*e*) What was the cost of construction?—The original cost per mile was over $250 per mile at a rate of 16 cents per cubic yard for earth; 25 cents per cubic yard for gravel; 35 cents per cubic yard for bowlders and all loose stone; $1 per cubic yard for all solid rock. Since the ditches were completed it has cost double the above amount to maintain them and to repair them.

(*f*) What is the cost per year for management and repair?—All the way from to $150 per mile, according to the number of "water spouts" and "cloud bursts" happen to strike the banks.

9. Do you buy or sell water? If so, state price paid or received.—We ha some water at $1 per acre per annum for land actually irrigated during the We have *also sold some* other water at about the same rate.

10. Have you all the water needed?—Yes, during the irrigating season.

11. What is the usual cost of bringing wild lands under cultivation? This to include plowing, grubbing off sage brush, fencing, etc.—Anywhere from $10 to $25 per acre. Any kind of reclamation will cost $10 per acre.

12. How many years are required to bring "wild land" into a proper condition for farming?—From three to six years, according to the sage brush, alkali, prickly pear, and general character of the soil and "lay of the land." If very gravelly and sandy it requires time for the sediment or wash in the water each spring to flow out upon the sand and gravel and form a soil that can not be excelled by any known process of fertilization. Say six years for this latter kind of land, and after the six years I firmly believe the land could be successfully cropped to the same product each and every year forever, as the soil is constantly renewed by the rich sediment or wash that comes down the stream with the spring freshets.

13. What did it cost you to prove up and obtain title to your land and what was the length of time required? If any difficulties were encountered state what they were?—I made final proof upon my land entries under very great hardships, such as travel overland through heavy snows and storms more than 138 miles to the then nearest land office, viz, Cheyenne; at great expense for road ranch bills en route for myself and witnesses, and, as all the witnesses were taken from their daily labor at their homes, I naturally had to pay them for the time consumed going to and coming from Cheyenne land office. My pre-emption proof cost not less than $400, my desert proof cost not less than $640. This includes the money paid to Government and cost of time paid for, and cost of transportation of all witnesses to Cheyenne land office and return, and advertising land proof, and expense en route and at Cheyenne. I was also subject to a four days' delay at Cheyenne after we had supposed the officials were all through, by their demanding a "copy of my marriage certificate," which at that time was hard to procure. As yet I have no land title other than the final receipt. It took about three years.

14. What has your cultivated land cost you per acre?—Not less than $20 per acre for the best, and all of it has exceeded a cost of $10 per acre.

15. What is the present market value per acre?—No land in this part of the country having changed hands at any price for a long time, owing to the uncertainty of our ever seeming to be able to secure titles and a consequent depressed state of affairs with all land entry men, it is impossible for any one to state any price with any kind of certainty, but I should judge any land thoroughly reclaimed and under a ditch to be worth $30 to $40 per acre.

16. Can you raise crops without irrigation?—No, most assuredly. No one can raise a crop or anything like a crop without irrigation, and after a residence of twelve years I have yet to see the crop raised without irrigation any where in Wyoming, and I have tried each and every season for twelve seasons. The trouble with our fair Territory is, that all the reports about raising crops without irrigation are made by the ever increasing majority of new-comers who are always welcome to our arid land, but with them the wish is "father to the thought" or rather belief (for they honestly believe so), for about all sections of our Territory put on a "splendid mantle of green" along in April and May, each year, but in June and July it all turns to a "golden yellow" invariably long before maturity.

It can not be termed a drought for it is the rule and not the exception; perhaps once in five years or once in three years a few potatoes or a small garden can be grown or partly grown without irrigation along some mud bar or bank, too, or island in the stream, but all such crops or so-called crops are irrigatad naturally and not grown by rain-fall by any means. During the year 1883 a good crop could no doubt have been raised by rain-fall in certain parts of Wyoming. But as the farmer can not possibly tell in advance what the rain-fall for the coming season will be, and as whenever there is sufficient rain-fall it only happens once in five years, it is utterly impossible to depend upon anything other than artificial irrigation, except in some of the mountain parks where there are such heavy winter snows that they melt very late in the spring and the ground there stays moist until after the middle of July, but here the crops fail, too, as often as they succeed.

17. Do you think the present land laws adapted to the conditions of the Territory?—No, I certainly do not think the laws are adapted to the conditions of our Territory or to anything like it to a small degree.

Among the changes I would suggest are, to allow each individual, reclaiming land in a bona fide manner, to enter 2,000 acres or less. This amount should be so allowed him to secure the cost and maintenance of the ditches and as an incentive to build the ditches. In other words, give title to 2,000 acres or less of good irrigable land as a premium to any one reclaiming, in order to partly re-imburse the entry man for the extraordinary cost of, and what is more important the maintenance of the ditches in the future years.

Let the State or Government officials determine by actual survey all the worthless *hill-tops* and other lands lying too high and rough to ever have water conducted

upon them by any means, and when this fact is positively ascertained allow the entry man as a free gift five acres (of all such worthless land and hill-tops lying adjoining to his good irrigable land) for each and every acre of land actually reclaimed, provided such worthless land must lie adjoining his 2,000 acres or less of irrigable land, on each side or along on one side and provided further, the entry man to pay Government the real cost of all such surveys. Also to allow all companies or corporations each alternate section of land (along under any ditch or canal) actually reclaimed by said company or corporation.

I am aware that the changes suggested by me as above will be looked upon with suspicion by some good people, but it must be remembered that these good people know nothing at all about what is really necessary to a successful reclamation of our arid Territory, and it is, to say the least, very unfair that they should have anything at all to say in the premises until after a residence of three to five years, engaged at an actual effort to cultivate the soil.

As the land is, in its natural state, it must lie forever worthless for ages. By a liberal policy, and allowing land enough to be entered to make it an inducement to capital to reclaim it, poor men will be constantly employed, and by their employment will be able to subsist and carry out in their turn their own plans and land entries on a smaller scale and in accordance with their means, whereas, as it now is, the poor man must obtain employment from some source or fail in his land entry entirely, as witness the many changes from one entry to another entry upon the same piece of land without attempting to prove up at all, thus exhausting two rights upon really one entry. And then, too, without any assurance that they will be any better able to prove up at the expiration of the second entry.

Allow no alien to enter any land until he has been a law-abiding citizen for five years, but allow any alien to acquire any lands by purchase from citizens, if he continues or keeps up the reclamation of such land by water.

Allow no contests for the right to enter lands or for the possession of title to same under any circumstances until three years after the original entry man had either failed to prove up or had really and actually abandoned his claim. Let all parties who have acquired a so-called title to land or any kind of a pretended possessory right whatever to improvements thereon or to the land or any part thereof "by contests" without first recognizing the original entry man, be forever barred and deprived of all their land rights as now existing or that may hereafter exist under the laws of our country.

I would modify the present land laws as they now stand by not requiring any actual residence upon any of them, but in lieu thereof insert a clause making the reclamation of all of the rights to lands by water compulsory, and not require any actual residence upon any of the claims where they had been honestly reclaimed with water. By honest reclamation of the land is meant the ownership by purchase or of appropriation of about 1 cubic foot flow of water per second of time for each 100 acres during the irrigating season, viz, during the months of May, June, and July, each year.

The central and best part of our Territory is traversed for its entire length by the "old Mormon trail," made when they left Nauvoo, Ill., more than forty-four years ago. Here, over the same old route, the California gold-hunters first traveled. Also the pony mail, and then the telegraph line to San Francisco, and afterwards Wells, Fargo & Co.'s overland stages.

The hundreds of mountain streams and small watering places, all crossed by this trail, all bear the plainest kind of evidence of having been quite thickly settled more than thirty years ago—old wells and old cabin foundations and stone chimneys all gone to decay, places where they had plowed for gardens and for grain, and some of the streams have from twenty-five to fifty graves scattered along their banks. There is almost any amount of evidence that Wyoming from the east to the west, through its entire length and best part, was all at one time fairly well settled upon its many streams more than thirty years ago. The question naturally arises why did not these old settlers stay upon their lands if crops can be grown without irrigation?

There are quite a number of people living in the Territory to-day who have been here from thirty to forty-five years, and it will be found upon investigation that all these old settlers have made their living in many other ways than by cultivating the soil. It is very doubtful if a resident of Wyoming can be found to-day who has, strictly speaking, taken his living from the soil for from three to five years, either with or without irrigation. They have all been trappers, hunters, employés of the Government, or had cattle, horses, or sheep, have been miners or freighters, any and everything other than tillers of the soil. The many hundreds of "deserted hearthstones" scattered all along the many water-courses of the Territory everywhere ought to convince the most skeptical that the desert-land entry man of to-day is right, and that our wise land-law-makers at Washington made no mistake on the side of liberality. The fact stands forth patent to all who are willing to make observations of the plainest character, that to remove our desert-land entry men and the cattle indus-

try from our midst the Territory must go back and become comparatively deserted again by its people as it once was thirty or forty years ago.

Should the Government allow the entry man 2,000 acres of the best irrigable land at each filing, it is very doubtful then if the entry man would have anything like 500 acres of available land for cultivation. Will any one say it is right and justice to allow 480 acres of good agricultural land to be entered in the humid regions under the three old land rights of homestead, pre-emption, and timber-culture, and not allow an equal amount entered in the arid region? The entry man in Wyoming should have four times as much land as elsewhere.

18. What should be done with the grazing land which can not be irrigated; what is the value per acre?—All grazing lands and other worthless lands adjoining any good irrigable land actually reclaimed should be given to the land entry man adjoining at the rate of 5 acres of all such grazing land for each and every acre of irrigable land actually reclaimed by said entry man, provided the entry man pays the Government the actual cost of survey of such grazing land. The balance of the grazing lands that are left upon the hands of the Government should be leased to the highest bidder for cash for a period of five to ten years, with the privilege of a renewal of the lease at its expiration at the same rate if desired and there is no higher bid meantime. Grazing lands are worth from 5 to 50 cents per acre, and there are thousands of acres of such land that are entirely worthless and will probably always remain so, owing to their sterility and roughness.

19. How do you regard the withdrawal of all public lands from settlement during the irrigation survey?—If the lands can be restored to entry under our present land laws again after they are so withdrawn or after the irrigation surveys are completed I certainly should be very much in favor of withdrawing all lands from entry, or if the lands can be restored to entry under a more liberal system of laws than we now have, I certainly should favor the withdrawal. But if they can only be restored to entry under the homestead law, and that, too, with a new requisite for an actual residence of seven years, I certainly should think it unwise to add that increased hardship, and should not by any means favor their withdrawal in the last case. The desert-land law as it now stands is by far the wisest law ever passed by Congress, not excepting any of them, and it should not be touched at all unless to allow more access to the entry man and the land to conform in a body to the entry man's ditch as regards grade of ditch.

We have in the "far West" a very large class of migratory citizens who do nothing but travel overland from some of the older States to Washington Territory this year, and from there to Montana the second year, and from Montana to New Mexico the third year, and so on, the greater part of their lives. Constantly on the move, over thousands of miles of wagon-roads, and they subsist upon and live off the broad generosity of their settled countrymen generally. If they do happen to settle down upon a claim they do not as a rule stay longer than six months or a year. This class would certainly give the Irrigation Survey trouble if the lands were open to settlement by coming in by the thousands to get a location long before the Government was ready, and this is the class, too, that gives the honest entry man any amount of worry and vexation by always putting in an appearance and wanting no other land only such as has been filed upon in good faith, and also by writing constant complaints to the officials at Washington.

It is my belief that for every bona fide settler now occupying public lands there are twenty-five of this migratory traveling class, on the move. And if, as is said to be the case, the Eastern people generally are opposed to the rapid settling up of the West, I beg to respectfully call your attention to the state of affairs all over the far West.

In a country where less than seven years ago was an entire vast wilderness from old Mexico to the British possessions and from the Missouri River to the coast, with the exception of a narrow strip along the Northern Pacific Railway and small parts of Texas and Colorado. I repeat that a very short time ago all, or about all, of this vast stretch of country was uninhabited except by Indians and some military posts, and is now completely overrun with people and towns, cities, and villages, railroads, civilization, and the honest settler can be seen upon any stream, brook, and little spring of water, go where one may, all over this vast far West. Oklahoma is a case in point, viz, 10,000 settlers to 10,000 land entries.

Let me say that the land legislators of our beloved country at Washington have made no mistake in so far as they have got. They certainly "builded better than they knew," but as applied to this arid country they did not go far enough. They certainly were not liberal enough. In other words, the wise and liberal provisions of our generous land law-makers at Washington could hardly be broad enough and liberal enough, so long as the many wide gates of our Castle Garden stood for so many years wide open to all the world.

Let us shut them up tight before it is too late, and bar them shut, too, with the strong bars of protection, and remember the old principle of "first come, first served." If by any chance any of our land entry men should acquire too much land.

the evil of it is imaginary, as it will cure itself if let alone, and as soon as they have acquired title they will dispose of it reclaimed. Unreclaimed, it will never be disposed of or benefit any one.

If the desert-land entry man made any mistake at all it was in not stopping to consider the value his capital and vast labor would give to a hitherto lot of worthless land, and consequently came a grand rush of people to all try and do the same thing in a country where for more than thirty years, the Government at Washington had asked the oft repeated question of what shall be done to cause the arid country to become an agricultural country, and at last, after many repeated inquiries and long years, the cattle industry has answered that question and answered it fully, and as a man naturally loves the country where he has succeeded in gaining a competence so the capital was forthcoming to build the irrigation ditches and canals. But it must not be forgotten that Bill Nye spoke the truth when he said, "It takes a great many acres of thin grass to make a fat beef steer," and it also requires large capital and any amount of the hardest kind of labor to reclaim desert land.

20. Do you favor the donation of all irrigable public land to the Territory?—Most assuredly I do favor the donation of all irrigable public land to the Territory, for then we should all stand some sort of a show of having justice done to a long-suffering and most patient lot of land-entry men the world has ever known. If the Territory owned all the lands the Territorial officials would (no matter of what political party or creed) be the judges of our wants and needs, and we should stand a fair show at least; whereas now the average man from any other section of our country knows nothing at all about our wants and seemingly can't be made to understand us, and really he can't be expected to help us until after a residence of from three to five years, trying to reclaim some of our arid lands and then, when he is won over (as they all are), his voice is drowned too by the ever-increasing majority of new-comers.

Incorporated Water Companies of Wyoming.

[Furnished by the secretary of the Territory.]

Name.	Principal office or place of business.	Date of incorporation.
The Wyoming Ditch and Water Company	Cheyenne	July 9, 1869
The Laramie Water and Ditch Company	Laramie	Mar. 27, 1871
Do	do	Sept. 13, 1874
The Albany County Ditch Company	do	Oct. 1, 1874
The Big Laramie River Water Company	do	Apr. 28, 1875
The Evanston Ditch and Water Company	Evanston	July 27, 1878
Pioneer Canal Company of Albany County, Wyo	Laramie	Apr. 22, 1879
Laramie River Ditch and Water Company, No. 1	do	June 19, 1879
The Rocky Mountain and Bear River Ditch Company	Almy	Aug. 19, 1879
Union Ditch and Water Company, of Albany County, Wyo	Cheyenne	Jan. 8, 1881
The Jack Creek Irrigating Company	Warm Springs	June 14, 1881
The Utah and Idaho Land and Irrigation Company	Evanston	Dec. 23, 1881
Hurlbut Creek Ditch Company	Johnson County	Jan. 25, 1882
The Upper Goose Creek Ditch and Irrigating Company	do	do
White and Jackson Creek Ditch Company	do	Mar. 8, 1882
Big Piney and Prairie Dog Ditch and Tunnel Company	do	Apr. 3, 1882
Trabing Creek Ditch Company	do	Aug. 14, 1882
North Piney and Prairie Dog Irrigating Canal and Tunnel Company	do	Aug. 21, 1882
The Wyoming Five-Mile Ditch Company	Bingham	Aug. 23, 1882
Upper East Side Goose Creek Ditch and Irrigating Company	Johnson County	Nov. 13, 1882
Chugwater Ditch Company	Cheyenne	Dec. 9, 1882
East Side Ditch and Irrigating Company	Johnson County	Dec. 11, 1882
Wyoming Development Company	Cheyenne	May 17, 1883
Hellman Ditch and Irrigation Company	Laramie County	June 18, 1883
Wyoming Development Company	Cheyenne	Aug. 10, 1883
Rutledge and Hellman Ditch Company	do	Aug. 21, 1883
The North Platte Irrigation and Ditch Company	Fort Collins, Colo.	Sept. 22, 1883
Goshen Hole Ditch Company	Cheyenne	Oct. 3, 1883
The McKuen Ditch and Reservoir Company	do	Oct. 5, 1883
The North Platte Irrigation and Ditch Company	Fort Collins, Colo	Oct. 12, 1883
Little Horse Creek Irrigating Company	Cheyenne	Nov. 1, 1883
Bordeaux Ditch Company	do	Dec. 29, 1883
The Deer Creek Canal and Improvement Company	Laramie	Jan. 15, 1884
Prairie Dog Water Supply Company	Sheridan	Jan. 19, 1884
The Sherman & Wood Ditch Company	Big Horn	Feb. 18, 1884
The Horse shoe Creek No. 1 Ditch Company	Laramie County	Feb. 28, 1884
Springvale Ditch Company	Cheyenne	Mar. 10, 1884
The Lodge Pole Ditch and Reservoir Company	do	Mar. 22, 1884
The Gordon Ditch Company	do	Apr. 10, 1884
Clear Creek Land and Ditch Company	Buffalo	Apr. 22, 1884

Incorporated Water Companies of Wyoming—Continued.

Name.	Principal office or place of business.	Date of incorporation.
The Crow Creek Ditch and Reservoir Company	Cheyenne	Apr. 25, 1884
Gall and Culver Ditch Company	do	Apr. 26, 1884
The Phillips Ditch Company	do	May 9, 1884
The South Side Ditch and Reservoir Company	do	May 20, 1884
J. H. Gordon Ditch Company	do	Aug. 26, 1884
The Cloud Peak and French Creek Ditch Company	Johnson County	Aug. 30, 1884
Beaver Dam Ditch Company	Cheyenne	Oct. 1, 1884
The Organ Ditch Company	do	Oct. 4, 1884
Bear Creek Ditch Company	do	Oct. 13, 1884
The North Lodge Pole Ditch and Reservoir Company	do	Nov. 12, 1884
The Whitehead Ditch Company	do	Dec. 22, 1884
The North Platte Irrigation and Ditch Company	Fort Collins, Colo.	Jan. 23, 1885
The Rawhide Irrigation Company	Cheyenne	Feb. 14, 1885
Little Medicine Bow and Richard Creek Irrigating Ditch Company	do	Feb. 27, 1885
The Payson Hutchinson Ditch Company	do	Feb. 28, 1885
Mead Ditch Company	Big Horn	Mar. 10, 1885
The South Spring Creek Irrigation Company	Carbon County	Mar. 16, 1885
Ontario Water, Ditch and Irrigating Company	Cheyenne	Mar. 25, 1885
Goshen Hole Irrigation Company	do	Mar. 27, 1885
The Little North Fork Ditch Company	Buffalo	Mar. 28, 1885
South Clear Creek Ditch and Flume Company	do	Apr. 3, 1885
North Laramie Ditch Company	Cheyenne	Apr. 4, 1885
Big Goose and Soldier Creek Ditch Company	Johnson County	Apr. 9, 1885
Piney Prairie Dog and Mead Creek Irrigating Company	do	Apr. 11, 1885
North Crow Ditch Company	Cheyenne	Apr. 20, 1885
The Four Lakes and French Creek Ditch and Flume Company	Buffalo	May 8, 1885
The Lake DeSmet Ditch Company	do	May 28, 1885
The Central Ditch Company	do	June 18, 1885
The Willow Creek Ditch Company	Cheyenne	Aug. 5, 1885
Hillsdale Irrigating Company	do	do
Agricultural Ditch Company	do	Aug. 8, 1885
La Bonte Ditch Company	Albany	Aug. 31, 1885
Wagon Hound Ditch Company	Cheyenne	Sept. 1, 1885
Tongue River Ditch Company	Johnson County	Sept. 5, 1885
Muddy Creek Ditch Company	Cheyenne	Oct. 5, 1885
Hereford Home Ditch Company	do	Oct. 7, 1885
Bates Creek Irrigating Ditch Company	do	Oct. 12, 1885
The Bresnahen Ditch Company	do	do
La Prele Ditch Company	do	Oct. 13, 1885
Big Goose and Beaver Ditch Company	Sheridan	Oct. 16, 1885
The Maverick Ditch Company	Cheyenne	Oct. 17, 1885
Big Horn Ditch Company	do	Oct. 21, 1885
The Willow Creek Ditch Company	do	Oct. 29, 1885
The East Beaver Ditch Company	do	Oct. 30, 1885
The Blue Grass Ditch Company	do	Dec. 4, 1885
North Bear Ditch Company	do	Dec. 12, 1885
Colorado Colony Ditch Company	do	Dec. 29, 1885
Valley Ditch Company	do	Dec. 30, 1885
The North Fork and French Creek Ditch Company	Buffalo	Jan. 2, 1886
Fetterman Ditch Company	Cheyenne	Jan. 4, 1886
The McDonald Ditch and Irrigating Company	Chugwater	Jan. 25, 1886
Silver Crown Ditch Company	Cheyenne	Feb. 8, 1886
Muddy Creek Ditch Company	do	Feb. 26, 1886
The Butte Ditch Company	do	Mar. 6, 1886
Darlington Ditch Company	Fort Laramie	Mar. 10, 1886
Fetterman Ditch Company	Fort Fetterman	Apr. 6, 1886
The Forney Ditching Company	Saratoga	Apr. 6, 1886
Laramie Peak Ditch Company	Denver, Colo	June 5, 1886
Little Box Elder Ditch Company	Cheyenne	June 16, 1886
The Douglas Ditch and Water Company	Douglas	June 17, 1886
Colorado Ditch and Reservoir Company	Cheyenne	June 19, 1886
Niobrara Ditch Company	Lusk	July 2, 1886
Union Ditch Company	Cheyenne	July 14, 1886
The Big Sandy Colony and Canal Company	Green River	July 23, 1886
Home Irrigation Company	Cheyenne	Aug. 23, 1886
South Clear Creek Ditch and Flume Company	Buffalo	Aug. 31, 1886
The Piney Divide Ditch Company	Johnson County	Oct. 30, 1886
The Highland Ditch and Water Company	Dixon	Nov. 11, 1886
Enterprise Irrigating Company	Saratoga	Mar. 8, 1887
Rialto Ditch Company	Cheyenne	Mar. 12, 1887
The Mesa Irrigating Canal Company	Dixon	Mar. 31, 1887
The Belle Fourche Irrigation Ditch Company	Sundance	June 20, 1887
The Fort Laramie Irrigating Canal Company	Fort Collina, Colo.	June 27, 1887
The Mead Ditch Company	Fort Laramie	Oct. 31, 1887
The Baggs Ditch Company	Baggs	Jan. 12, 1888
The Murphy-Collins Ditch Company	Laramie	Aug. 11, 1888
Glenrock Land and Canal Company	Glenrock	Mar. 20, 1889
The Crown Ditch Company	Buffalo	Apr. 5, 1889
The Mammoth Canal and Improvement Company	Green River	June 10, 1889

STATEMENT OF STEPHEN W. DOWNEY, OF LARAMIE.

ith the mass of statistics before you, it is hardly necessary that I should dwell n the practical benefits of irrigation, as that point has been fully examined by your mittee; but I desire to suggest some plan of action in reclaiming the vast areas terile lands in the Rocky Mountain region and on the plains to the east of it.
overnment land is becoming scarce, and it is a serious question what to do with surplus population and how to preserve the equilibrium between the thinly and kly settled portions of our common country. The nations of the Old World have compelled to resort to vast and expensive schemes of colonization in order to ide for the excess of their population, and it will be but a short time, probably re the twentieth century arrives, when this question must be met by the Congress he United States, as we have but little vent for our restless and enterprising popu-u. The only solution is to render available the vast domain which at present sterile and useless to the home-seeker, who can not have means sufficient to se- w:ter for the thirsty soil, which he could cultivate and upon which he could es-ish his home. I believe it to be the duty of Government to assist him and those will accompany him in finding a home and in the consequent development of the try. There is surely sufficient warrant in this action, as Congress has for de- s expended vast sums of money in the improvement of rivers and harbors, in ecting the lands adjacent to the Mississippi River from overflow, in providing he reclamation of swamp-lands, and in a multitude of directions.
ther one of two plans should be adopted.
) Congress should appropriate yearly a considerable sum of money to the purpose stablishing reservoirs, diverting useless waters to streams where irrigation is ticable, and take upon itself the reclamation of the arid lands. Where the ams have deep beds and precipitous banks, and where the land through which flow can not be made susceptible of irrigation, the waters should be diverted reams and sections where the water can be made available for irrigation. If this be adopted, the Government could part with its lands at an enhanced price, ring the outlay and a reasonable compensation over the cost of constructing rvoirs and maintaining a system of reclamation, and thus recoup the amount ex-led.
) If this plan is not deemed feasible, the lands should be donated to the State, itory, or county within whose limits the same are, for the purposes of reclamation, authority to issue bonds for reclamation purposes, to be paid from the proceeds he rental or sale of these lands, under a maximum and minimum price.
either of these cases, so far as is possible, the purchase of lands by any one indi-ual, association of persons, or corporation, should be limited in extent, and safe-rds should be established, which shall prevent the absorption of these lands by ulators. This limit should not be less than one section of land for agricultural poses, with a larger area for grazing purposes.
can not imagine any other methods by which this great domain can be settled its settlers made prosperous. There will always be a home market for the prod- of the soil, and with the increase of our population the surplus will all be led at home.
he great stride in the right direction made by the passage of the homestead law ld be supplemented by this step. We must do something to satisfy the land hun- of the people. It is conceded that the most intelligent, prosperous, and valuable ion of our communities is the farmers. What the peasantry is to France, its t conservative and moral class, the tillers of the soil are to this nation.
he rapid increase of population at our commercial centers, composed largely of e-workers and those who are dependent upon the employment of others, creates ass which, being dependent, will be discontented and subject to the wind of doc-es and the appeals of doctrinaires, and the stability of our Government and the nanency of our institutions and the preservation of our Government must rest in future, as it has in the past, with the agricultural classes of the country. While ranches of the industries have been protected by Congress and guarded to the ost by the Government, the great farmer class of the country have received but e aid compared to the efforts which have been put forth on behalf of the com-cial and manufacturing interests of the country.
he present time is most propitious for this undertaking on behalf of the Govern-t, and it is but in harmony with the generosity of the Government towards the ple of the Territories. A continuation of this policy would achieve grander re-s and afford an outlet to our rapidly-increasing numbers, increase our wealth the prosperity of the country, and found in the shadows of the mountains a mighty ire, whose sons in time of war would defend their generous mother with their ice, savings, and blood.

ADDITIONAL STATEMENT OF CHARLES H. BURRITT.

[As corresponding secretary for Johnson County Mr. Burritt prepared the following for the Territorial Board of Immigration. It was submitted to the committee and ordered filed:]

Only a few years ago agriculture in Johnson County was not considered an industry worthy of consideration. This was the fact in 1881, as the following figures of assessed valuation for that year show:

Cattle in 1881	$1,047,688
Lands in 1881	34,485

The great distance from railroads and the demand for vegetables and grain for home consumption forced the people to experiment with crops. The result was startling, and the sequel was that the business of farming became a leading industry within the next five years. Land "proved up" in Johnson County is assessed for taxation at a value of $3 per acre, including improvements. It is easily worth an average of $10 per acre. The following table of values from the assessment roll of lands shows the increase from 1881 to 1887 in farming lands:

1881	$34,485	1885	$166,032
1882	51,195	1886	229,644
1883	66,160	1887	485,439
1884	147,785		

The real taxable value of this taxable land is at least three times this amount, or in 1887 $1,456,317, which is $408,649 more than the value of the cattle in 1881.

But one-fifth of the lands in Johnson County susceptible of irrigation have been artificially watered. The total area of irrigable lands is estimated at 953,000 acres, and at an average value of $10 an acre would be worth $9,530,000.

The county is in the northern part of Wyoming. Its elevation is only about 4,000 feet. Its streams are more frequent and available than any other portion of the Territory.

It is also one of the best watered counties in Wyoming, being well supplied with innumerable streams heading in the Big Horn Mountains and flowing generally to the northeast and northwest. The water along the foot-hills is clear, cold, sparkling, and soft. The soil is black and sandy loam, and appears to be capable of producing wonderful crops, with irrigation, of any thing that is planted in it.

AGRICULTURAL PRODUCTS.

The agricultural products of the county are wheat, oats, barley, corn, rye, hay, potatoes, vegetables, and fruits. The yields are: Wheat, 20 to 50 bushels per acre; oats, 25 to 75 bushels per acre; barley, 40 to 75 bushels per acre; rye, 20 to 40 bushels per acre; potatoes, 200 to 500 bushels per acre; hay, native blue stem, 1 to 2½ tons per acre; timothy, 2 to 3 tons per acre; alfalfa (lucern), 4 to 6 tons per acre.

The wild fruits are strawberries, raspberries, plums, choke cherries, service berries, wild currants, etc. Tame fruits are strawberries, raspberries, blackberries, currants, crab apples, etc. Strawberries especially grow to perfection. Wheat may be sown in March or April; even that sown in May fully matures three years out of four. In 1887 there were approximately 1,729 acres of wheat cultivated, and the total production was 38,000 bushels, or 2,228,000 pounds. The wheat raised is classed as A1. This cereal is being raised largely in Johnson County to fatten hogs, and even in this way is made to yield a good return. Barley, if sown in early April, can be raised on valley soil without irrigation and of the finest quality. Seventy-five bushels have been raised on an acre. The approximate number of acres in cultivation in the season of 1887 was 345, with a total production of 25,525 bushels, or 1,225,200 pounds. In 1888 a much larger crop was raised.

The malt used by the local breweries is made from home-grown barley and is fully equal to the eastern product. Oats are usually sown in April or May. Oats sown June 20 or 25 have returned fully matured crops of 50 to 60 bushels per acre. While the yield is, as usually, from 25 to 60 bushels per acre, as high as 95 and 105 bushels have been produced. The best crops of Johnson County in 1887, according to location as to valleys, were: Powder River, 37½ bushels per acre on 15 acres; Crazy Woman, 67 bushels per acre on 12 acres; Clear Creek, 65 bushels per acre on 10 acres; Piney, 60 bushels per acre on 25 acres; on French Creek, 75 bushels on 10 acres; on Rock Creek, 70 bushels on 100 acres. The approximate number of acres in cultivation in the year 1887 was 7,861; total production 234,475 bushels, or 8,441,130 pounds. The *average weight* of a bushel of oats is from 38 to 40 pounds. Corn was the last of the *cereal crops* introduced in the country. While not the most remunerative thus far

it has been successfully grown. The Yellow Dent corn fully matures on our soil, and larger fields are planted every year. As this is the home of the solanum family of plants the potato grows to perfection; it is nothing uncommon to see potatoes weighing from 1 to 4 pounds, dry, mealy, and solid all through. The average yield of the tuber is about 200 bushels per acre; but under favorable conditions there have been 300, 400, and, on rare occasions, 600 bushels per acre raised on ground not manured.

Cabbage grows in very large size and the yield per acre is simply enormous. Heads of 25 and 30 pounds are common; 10 to 15 tons are often raised per acre. Cauliflower is also easily grown owing to the cool nights and the system of irrigation by which the plant can be watered at just the right time to perfect them in growth and development. Onions are an excellent crop, yielding from 300 to 500 bushels per acre of perfect bulbs. The celery raised here is pronounced to be superior in flavor to the famous celery of Kalamazoo, Mich. All other vegetables, such as beets, carrots, parsnips, etc., grow to a large size and yield immense crops. Melons, cucumbers, tomatoes, peppers, egg-plant, broom-corn, tobacco, sorgum-cane, beans, and many other vegetable productions are successfully grown in Johnson County. In 1888, according to thrashers' figures, the oat and wheat crop of Johnson County and Sheridan County was 400,000 bushels; estimated at 350,000 bushels of oats and 50,000 bushels of wheat, which would equal, oats 12,000,000 pounds and wheat 3,000,000 pounds; a total of 15,000,000 pounds or 700 car-loads. The oat and wheat crops of Johnson County alone will equal that amount in 1889. Johnson County can produce equally as good potatoes as Greeley, Colo.

As to the future: If one-third of the irrigated lands of this county were sown in wheat at at an average of 30 bushels per acre it would yield 2,340,000 bushels or 130,400,000 pounds, equal to 7,244 car-loads. If one-third of the area was sown to alfalfa it would produce 192,000 tons annually, and would fatten 58,400 steers, equal to 2,900 car-loads. Not more than one-fifth of the lands of Johnson County susceptible of irrigation have been watered. The possibilities that may be attained when development is complete become enormous. Johnson County will soon have railroads. For its agricultural products there is a ready market in the south.

STATEMENT OF H. B. PATTEN, ENGINEER OF THE WYOMING DIVISION, UNION PACIFIC RAILWAY.

In cases of aridity water is obtained by sinking wells, which, in some cases, are deep enough to be called artesian. Some wells supply large quantities and others only limited. Difficulty is to find water at all under ground; or, when found, to secure quality. Much that is found is extremely poor, being strongly alkaline.

Eighteen artesian wells have been driven, averaging 907 feet in depth. These vary in depth from 300 to 2,300 feet. They cost from $5 to $16 per foot, according to nature of boring, depth, and difficulties experienced, etc. Average cost of those driven is $6,700 per well, or per foot, $7.39.

Of those driven, a total of eighteen, nine are now furnishing fair to good supply for engine use. The other nine are either poor in quality or limited in quantity.

Do not know of any water storage system in use in this country.

Can furnish no direct observations for precipitation, etc., but can refer you to United States Signal Observatory at Cheyenne and to records of observations made at Rawlins by Union Pacific Railway. Subterranean water supply is of not infrequent occurrence. The dry beds of creeks usually have underground flow. The direct appropriation and immediate distribution of water from flowing streams in surface ditches for irrigation is the common and well-nigh only method used.

Irrigation enterprises are common. Large ditches are increasing in size and number. In Wyoming, what are generally known as the Sybille ditch, Pioneer Canal from Laramie River, and Bear River Canal are amongst the largest schemes.

For agricultural purposes water is essential. There are large tracts of land, of very fertile soil, which are now utterly non-producing. Water is the lacking element to the growth of large crops.

STATEMENT OF LOUIS BRECHEMIN, ASSISTANT SURGEON, U. S. ARMY, OF FORT LARAMIE.

For the eastern half of Wyoming Territory it may be stated that farming without irrigation can not be successful and can not be made fairly remunerative under the most favorable circumstances and with the best lands. In looking over this part of the Territory it is at once evident that but a small proportion of the land can receive by irrigation a supply of water sufficient for its needs owing to the fact that the streams are small, insufficient in number and capacity, and so situated that hardly a hundredth part of the land can be utilized. The valleys generally are narrow (the soil in many places sandy) and are surrounded by hills on each side. In order to irri-

gate successfully, that is, to get the water up on these high lands, it must be brought from a great distance and necessarily therefore at great expense. In consequence of this no combination of small farmers can afford to advance the large amounts required to construct these ditches and an association of capitalists for this purpose is imperative.

In examining the valley of the North Platte River, from the hills to the Nebraska line, it is seen that even in this valley, watered by the largest stream in the Territory, irrigation up to the verge of the banks of the river is necessary in all instances in order to raise crops. Occasionally the native grasses grow in spots, due to subirrigation from overflow of the river when it is high.

In rare instances, on second bench land where the prickly pear is plenty and where these are turned over thoroughly by the plow and left to remain under the fallow, not being disturbed by the harrow, there is moisture sufficient created by them to produce a medium crop. This is known as the sod crop and is always better than the second crop, unless the land is irrigated the second season.

When we take into consideration the high winds so prevalent in this county, the danger to ditches by occasional cloud-bursts, the extreme shortness of the season for anything but bulbous vegetation, &c., it may be stated with justice that the eastern portion of Wyoming is not an agricultural country.

These opinions are not altogether the result of personal experience, but have been formed and strengthened by inquiries made of those engaged in ranching in this section. One of my informants has had twenty-two years' experience and has expended large sums of money in experiments of various kinds during that period.

STATEMENT OF J. A. OLMSTED, CAPTAIN, NINTH CAVALRY, COMMANDING, OF FORT WASHAKIE.

From my experience in Texas, Utah, Kansas, New Mexico, and Wyoming I believe there is very little if any land in the United States that can not be profitably cultivated if water can be obtained to irrigate. When there is no surface water to be obtained wells, common or artesian, will always reach it. But the latter are too expensive for private individuals and will have to be made by the Genenal Government.

STATEMENT OF A. H. JACKSON, CAPTAIN, SEVENTH INFANTRY, U. S. ARMY, OF FORT WASHAKIE.

Information upon the subject of reclaiming waste lands by irrigation, derived from actual experiment and observation, extends little beyond the primitive cultivation of sage-brush lands employed by troops in the Northwest and ranche people in their vicinity.

Land of this character will usually produce good crops of grain and vegetables, with little expenditure of labor after that, of constructing the system of ditches for its irrigation.

In the selection of land, its adaptability to artificial irrigation is, of course, the first consideration. Sage-brush will soon disappear in the process of irrigation alone, which also serves in a large degree to relieve the soil from alkali deposit, provided there be a sufficient incline to carry it off.

A settler will do wisely, however, in avoiding land of the latter description altogether.

I have no practical knowledge of the larger systems of irrigation sometimes carried out in the Northwest at great expense and necessary in reclaiming the arid plains of the Southwest.

STATEMENT OF WILLIAM QUINTON, CAPTAIN, U. S. ARMY, FORT WASHAKIE.

Can only give the result of observation from the management of company gardens in Montana and Wyoming. The result of such observation is—

(1) No one single thing can be raised in the Territories referred to without irrigation.

(2). The soil is very rich, and although the growing season is rather shorter than the east, everything can be raised by means of irrigation.

(3) Ditches ought to be of sufficient depth to prevent the overflow of the soil intended to be irrigated—as the presence in the soil of large deposits of alkaline salts causes, from the action of the sun, over-hardening of the soil if overflowed. However, feeding the soil with a liberal supply of stable compost, coupled with frequent irrigation, will in the course of a few years' cultivation remove these salts.

WESTERN NEBRASKA DIVISION.

OGALALLA, NEBR., *September* 19, 1889.

The committee met pursuant to call of the chairman.

Present: Mr. Stewart, (chairman), also Director Powell.

STATEMENT OF ALFRED HOLLINGSWORTH, OF OGALALLA.

The CHAIRMAN. What is your occupation?

Mr. HOLLINGSWORTH. I am a physician and am engaged in farming.

The CHAIRMAN. How long have you resided here.

Mr. HOLLINGSWORTH. Since the spring of 1885.

The CHAIRMAN. What do you say as to the sufficiency of the rain-fall to produce regular crops here?

Mr. HOLLIGSWORTH. My experience has demonstrated to me that it is entirely insufficient.

The CHAIRMAN. You do occasionally raise crops here I suppose?

Mr. HOLLINGSWORTH. In certain localities, where local showers happen to come at the right time. But taking the amount of acres the country over in these parts, the crop is very light.

The CHAIRMAN. Can you mature all sorts of crops here?

Mr. HOLLINGSWORTH. As a usual thing the crop dries out and burns up for want of moisture before it comes to maturity.

The CHAIRMAN. Are you familiar with the State farther east?

Mr. HOLLINGSWORTH. I have seen people from the extreme eastern part of the State. I have traveled about a good deal by private conveyance and have always made inquiry about the crops.

The CHAIRMAN. How far east of here does this deficiency of rain-fall interfere with the regular production of crops.

Mr. HOLLINGSWORTH. I would place it about 100 miles east of here.

The CHAIRMAN. And they sometimes have failures east even of that?

Mr. HOLLINGSWORTH. Yes, two years ago they did have.

The CHAIRMAN. Have any measures been taken here to increase the moisture by irrigation or by the artificial storage of water?

Mr. HOLLINGSWORTH. There is an effort being made at the present time to do that.

The CHAIRMAN. Is there any land under irrigation here?

Mr. HOLLINGSWORTH. No, not in this county. There is irrigation in the western part of Lincoln County, the adjoining county on the east, on the Platte Valley.

The CHAIRMAN. Where do they get their water from?

Mr. HOLLINGSWORTH. From the North Platte River.

The CHAIRMAN. How far is it from here to the North Platte?

Mr. HOLLINGSWORTH. Six miles straight north.

The CHAIRMAN. Is there any irrigation on the North Platte opposite here?

Mr. HOLLINGSWORTH. No.

The CHAIRMAN. Nor west of here?

Mr. HOLLINGSWORTH. I think not. There is none that I know of.

The CHAIRMAN. Did you ever live in an irrigated country?

Mr. HOLLINGSWORTH. No; but I have been investigating the water supply for irrigating purposes for the last six weeks or two months.

The CHAIRMAN. You have seen no storage of water or any irrigated country yourself?

Mr. HOLLINGSWORTH. No.

The CHAIRMAN. How have you investigated the question of water supply?

Mr. HOLLINGSWORTH. We have been working up an irrigation scheme for the South Platte River here about twenty-five miles.

The CHAIRMAN. Is your engineer here?

Mr. HOLLINGSWORTH. Yes.

STATEMENT OF L. E. HICKS, OF LINCOLN.

The CHAIRMAN. What is your occupation?

Mr. HICKS. I am professor of geology in the Nebraska State University.

The CHAIRMAN. I presume you are pretty familiar with the State, and have given some attention to the subject of irrigation. We shall be glad to hear any statement on that subject which may be of use to us in our inquiry.

Mr. HICKS. I have given attention to the subject of irrigation ever since I came to reside in Nebraska. I have felt a deep interest in it, and have had and now have a very strong conviction of its necessity and importance.

There are certain things that I had prepared to say at Cheyenne, which I will say here, though I will not now say all that I intended to say there, because that place would have been appropriate for certain things which it is not necessary to say now. To a certain extent, however, the scope and direction of my remarks will be influenced by the fact that I prepared to speak at Cheyenne.

I have prepared hastily a map, which may be marked "Hicks, A." All that I did had to be done hastily because I had very short notice. I prepared this map as exhibiting the Platte River and its tributaries, as the main feature of the map, although it includes the whole of the State of Nebraska. The State boundaries are indicated by dotted lines to a portion of Kansas, a portion of Colorado, and a portion of Wyoming. The political divisions are not conspicuous upon the map and I did not intend to make them so.

The CHAIRMAN. You regard political and State lines as having nothing to do with irrigation?

Mr. HICKS. That is the point I wished to make by exhibiting this map of the State. Political boundaries should be non-existent so far as irrigation is concerned. I do not think I need to dwell upon that after simply stating it and calling attention to the physical features of this region, which emphasize the fact that State boundaries ought not to be considered as having anything to do with the question of where the water is to go or where it is to come from. We ought to consider a certain region (without regard to State boundaries) in its physical aspect as a hydrographic unit.

The Platte River is a remarkable stream in many respects. It is one *of the large* rivers of the world, considered with respect to its length.

The South Platte rises in the southern part of the Rocky Mountains, and the North Platte in the northern part. Each of those branches of the Platte is an important and valuable stream for irrigation. Not only so, but the numerous tributaries of the North Platte and the numerous tributaries of the South Platte are all valuable streams for irrigation.

I do not propose to speak at any length of the South Platte. We have a great interest in the South Platte, and the people of Ogalalla are particularly interested in it, but I propose to speak more particularly of the North Platte, because I think there is more value and more hope for Nebraska in the North Platte than in the South Platte. The State of Colorado includes a large portion of the South Platte. There are about 80 miles of the South Platte in Nebraska. I hope the committee will take a ride across the South Platte, and see it for themselves.

The CHAIRMAN. You may explain the condition and capacity of that stream.

Mr. HICKS. I have not proposed to say very much about the South Platte, as it would take me some time to say about it all that I should like. I should like to say why I believe that in the long run the use of the waters of the South Platte is going to benefit the people along here, because it will fill up, soak up, the lands in Colorado so that the lands themselves will become a great reservoir to gradually and constantly yield waters to fill the Platte along here and all the way down to its confluence with the North Platte and ultimately be beneficial. That, however, would take a long time. It will be hastened by the measures now being prosecuted under the authority of the General Government by the U. S. Geological Survey under the direction of Major Powell.

The taking out of the surface waters—the flowing waters—in the streams during irrigation season has deprived the people here on the South Platte of water, and has been an injury to them by taking the water which otherwise would flow through the South Platte. The beneficial result which is ultimately going to come from irrigation in Colorado will be hastened by this irrigation survey and by the construction of hydraulic works in the places which will be indicated by the survey. I understand that the survey conducted by Major Powell is not to construct anything but to indicate the places where reservoirs for the storage of storm waters may be advantageously placed, and how much it will cost to build the dams and make the reservoirs. I understand the intention is to furnish information so that individuals or companies may do the work.

The North Platte is a stream which has not yet been used up by irrigation in Wyoming as the South Platte has been in Colorado. The North Platte is a larger stream than the South Platte. It possesses many great advantages for irrigation. The whole Platte River in fact presents great advantages for irrigation; in one respect greater I think than any river of the same size in the world, namely its high gradient. For the size of the Platte River it is slow, the amount of fall in it is very remarkable. From Fort Steele away up in Wyoming—not at the head of the North Platte, but within 150 miles of the source of it—down to the mouth, the average fall for the whole distance is over 7 feet to the mile. If you carry the measurement up to the very sources of the Platte, of course it would be much greater, because the upper waters have a steep slope. The slope in different parts of the river vary a great deal, but it may be of interest to you to hear the details of the gradient of the Platte in different portions of it.

From Fort Steele to the Wyoming line the average gradient is 8.6 feet per mile; from the Wyoming line to the town of North Platte it is 7.4 feet per mile. I do not think you can find any other river of that size which has so high a gradient as the North Platte for so long a distance. That is certainly a very high gradient and, you know very well what that means in respect to its value for irrigation. If a stream has very low gradient and you take a ditch from it you have to go a long distance before you can get the water in. From North Platte to Kearney the grade is much less, being only 5.6 feet per mile and from Kearney to Fremont, singular to say, the grade is higher than it is from North Platte to Kearney, being 6 feet. The average for the whole distance from North Platte to Fremont is 5.8 feet.

There are many characteristics of this stream and of the country which it waters which I should like to point out in detail, but I think I have said enough to indicate what admirable provision nature has made for furnishing water to a very large piece of country, and it only needs the guiding hand of man to pour out its beneficent results on these plains to produce values in agriculture which can be expressed only by millions of dollars.

I shall return now for a moment to the subject of this map to illustrate the physical features of the Platte.

The CHAIRMAN. I should like you to state what the topography of the country is on each side of the river.

Mr. HICKS. I had intended to speak of that but do not want to make my remarks too long. If I speak of the lay of the land I shall be getting at that important point with respect to a very large section of Nebraska, and therefore it is perhaps as pertinent here as to speak of it in detail with regard to other streams.

The CHAIRMAN. I should like, if you are familiar with that stream, to have you state the elevations, and the opportunity for getting at the water also the extent of land that could be covered by it, commencing with the point at which you begin with the fall or grade of the river.

Mr. HICKS. With regard to that part of the river that is in the Territory of Wyoming you have had the facts from the engineer of that Territory, Mr. Mead.

The CHAIRMAN. That was as to the deep channel, but you commence where the channel is low.

Mr. HICKS. In the upper, or Wyoming, portion of the Platte a great deal of it flows through cañons, so that the taking out of the water would be difficult, but near the place where it crosses the west line of Nebraska (the Nebraska-Wyoming line) it comes out from the cañons and flows through a comparatively level country; in some places high banks on one side or the other, and on the whole, its valley is deep. The hills, when you get back to the crest, are high all along, but the slope is gradual, especially on the north side. It is no longer a cañon at that point, and therefore it can be taken out for irrigation in western Nebraska and to some extent in Wyoming, on the north side. On the south side there are bluffs all around here.

The CHAIRMAN. How far?

Mr. HICKS. To a distance of 30, 40, or perhaps 50 miles from the Nebraska line.

The CHAIRMAN. About midway between Platte and the Wyoming line?

Mr. HICKS. Yes; between North Platte and the Wyoming line the water can be taken out on the north side. There is one point to which I wish to call attention, which in the end may be a point of very great

importance, although it will probably involve engineering operations and an expenditure of money on a very large scale.

Speaking of the facility of taking out the Platte, there are two theories of it. The question is whether it is easier to take it out in short ditches to water the lands that lie at a moderate elevation above the stream, or whether to take it out and carry its waters upon the high plateaus, upon the divides or table lands. If you take it out in the latter aspects, if it is proposed to carry the Platte upon the table-lands north of the Platte, you have to contemplate engineering operations upon a large scale—I will not say upon a vast scale, because in India they take out ditches as long as 500, 600, or 700 miles. To take out the waters of the Platte and spread them upon the table lands would require a ditch at least 150 miles in length, which is a great undertaking and would involve the expenditure of large sums of money, and it could only be done by a great corporation, or by national or State authority.

The CHAIRMAN. State which would be the most economical way in the end, per acre.

Mr. HICKS. To carry it out on the table-lands, or to use it in the valley?

The CHAIRMAN. Yes; which would be the most economical, taking into account the quantity of land that would be benefited?

Mr. HICKS. My conviction on that point is that the proper thing to do is take it out on the table-land.

The CHAIRMAN. Where would you take it out?

Mr. HICKS. I would go as far as the mouth of the cañon in Wyoming—the North Platte cañon, west of the Nebraska line.

The CHAIRMAN. If you had a ditch running out on the north side, explain where it would run?

Mr. HICKS. There is a vast body of table-lands between the Niobrara and the North Platte.

The CHAIRMAN. That river runs nearly parallel to that north line we call the Niobrara?

Mr. HICKS. Yes.

The CHAIRMAN. What is the average distance between the Niobrara and the North Platte, at about the one hundredth meridian?

Mr. HICKS. About 100 miles.

The CHAIRMAN. What length of ditch would it take to run it out at the mouth of the cañon and run it to the meridian?

Mr. HICKS. That would be well on to 200 miles.

The CHAIRMAN. And if you went down to the ninety-eighth meridian you would have something further to go?

Mr. HICKS. About, probably, 320 miles.

The CHAIRMAN. What is the character of the soil on that plateau?

Mr. HICKS. It is excellent. It is of the character which generally prevails upon the table-lands and in all this belt of country. The table-lands have a soil which is very rich in all the elements of fertility and has a subsoil compact enough to hold the water without being hard pan to prevent the water from entering it and being retained by it. It has the necessary porosity to have that quality to a useful extent, without having it to such an extent as to waste water. Therefore in every respect the table-lands are excellent for containing water and for its application to irrigation.

The CHAIRMAN. And for retaining water in the ditch?

Mr. HICKS. Yes.

The CHAIRMAN. They are better for retaining water in the ditch than the gravelly bottoms?

Mr. HICKS. Yes.

The CHAIRMAN. It would be an economical use of water to take it out there?

Mr. HICKS. Yes.

The CHAIRMAN. What do you say as to the quantity of water in the North Platte to supply such a ditch?

Mr. HICKS. I have never gauged the North Platte, and can not speak with any positiveness as to that. Major Powell could inform you better than I can on that subject.

The CHAIRMAN. Have you ever seen the North Platte in flood time?

Mr. HICKS. Yes.

The CHAIRMAN. Is it a large stream, then?

Mr. HICKS. It is an immense stream.

The CHAIRMAN. What would be the opportunity of storing the water to supply such a ditch?

Mr. HICKS. There are good places for storage basins to contain the flood water.

The CHAIRMAN. Suppose you have it on the summit of a ridge, would you be able to make reservoirs to catch the water in flood time as you followed the Niobrara on one side and the Platte on the other?

Mr. HICKS. Yes; there are such places.

The CHAIRMAN. So that you could enlarge the quantity?

Mr. HICKS. You could enlarge the quantity by retaining the waters that fell along the course of the ditch.

The CHAIRMAN. What do you say of the flood waters with which you could augment the stream between the Niobrara and the Platte? Do the rains fall there to a considerable extent?

Mr. HICKS. The rain-fall has never been carefully investigated in that region. The stations for the investigation of rain-fall are none of them so situated as to do that, and it is impossible to say with positiveness what the rain-fall is, but I am safe in declaring that it is certainly 15 inches or over. With that amount of rain-fall you can form an idea of the amount of the flood waters which might be saved.

The CHAIRMAN. What is the character of the surface—has it got basins and ravines and unevenness enough to find storage places or places to catch water?

Mr. HICKS. The topography is extremely favorable for storage. I might perhaps qualify that word "extremely." It is favorable. It is certainly as favorable as the average conditions over the county, if not more so.

The CHAIRMAN. I observe by that map that between the two rivers you have other streams marked.

Mr. HICKS. Yes. Those are the Loup rivers and their tributaries—the whole being tributary to the Platte.

The CHAIRMAN. Have you got on the map all the rivers and ravines that are between those rivers?

Mr. HICKS. No. This map was hastily constructed to bring out certain points especially the point that State lines ought not to come into account. There are many streams that are not on the map. I have not put in any tributaries of the Niobrara River.

The CHAIRMAN. Independently of taking the water from the Platte, which of course must ultimately be done (that would be a great enterprise), what are the opportunities for storing the storm water, to begin with?

Mr. HICKS. Do you mean over the surface generally?

The CHAIRMAN. Over the surface generally.

Mr. HICKS. In my belief the opportunities are good.

Director POWELL. Will you please state a little more fully the advantage of taking the North Platte out upon the divide between the Niobrara and the Platte itself—the advantage of taking it out upon a high line to the region between that high line and the Platte itself?

Mr. J. J. MCINTOSH (of Sidney, Nebr.). I would suggest that the examination be confined to the country west of the one hundredth meridian, as east of that line it is not claimed that it is necessary to have irrigation.

The CHAIRMAN. I think that irrigation is not confined to that meridian any more than it is to State lines. Let us have the facts.

Mr. HICKS. I am going to answer the question, but I wish to get at it by a circuit. The proposition I have made about taking out the North Platte may seem to be a rather startling proposition because of its magnitude, but if it can be shown that there are certain great advantages that can not be secured in any other way, then we will contemplate that proposition.

In answer to a suggestion of Major Powell's, I will bring out one of the things which constitutes a great argument for attempting work on a large scale like that. It is that by taking out these waters upon the high divide here you have them at an elevation above the stream, and with a slope between the main ditch and the stream, which includes a vast body of land—land that is well suited for irrigation, almost every acre of it, and which lies upon this slope between that main ditch and the Platte in such a way as that when you have used the water up here next to the ditch, upon the highest part of that divide, and irrigated your fields there, the same water will come on down and irrigate the fields which lie a little lower, nearer the Platte. Then, after irrigating those fields you take it again and irrigate other fields, and so on, using the water of that main ditch over and over again. That is one of the great advantages of attempting things on a large scale.

The CHAIRMAN. If you had the ditch, need it necessarily be on a very large scale to irrigate some lands?

Mr. HICKS. No.

The CHAIRMAN. And as you extended it along here you would cover a great deal of land with every mile, would you not?

Mr. HICKS. Yes.

The CHAIRMAN. The work done would be a great deal larger as you went along. When you irrigated this land along the ditch and filled it with water, would not that filling of water work along down and fill the land towards the river, saving the water all the time?

Mr. HICKS. Yes.

The CHAIRMAN. And go of itself down towards the river?

Mr. HICKS. Yes.

The CHAIRMAN. And if you were up here on the high divides could you not start your ditches and make reservoirs below it, to save your surplus water and do a good deal more work with it than if you took it out on the low beds; would it not get right back into the river there?

Mr. HICKS. Yes, and there are other reasons why it is not so good. I may introduce some qualifications here. Job said, "Oh * * * that mine adversary had written a book." I wrote a pamphlet about this subject once. I contemplated taking out the North Platte and am in a measure going back on my record.

The CHAIRMAN. Are you familiar with the facts as to how far east the water would be useful if that ditch was extended? I am not put-

ting it at the bare point of necessity where you could eke out life on that land, but how far would it be useful to extend that ditch?

Mr. HICKS. If I should answer that question just as it lies in my mind I should take it out clear to the Missouri River. I maintain that the use of water in irrigation would be advantageous on account of its increasing the yield and making the yield certain, giving you the opportunity to put the water on the land just when it needed it, instead of waiting for the clouds to pour it on. They do not always bring it when it is needed. Therefore, on account of the certainty of the results and of the increased yield of the fields, I say that water for irrigation could be profitably used all over the State of Nebraska, but I do not believe you intended the question exactly in that sense.

The CHAIRMAN. I wanted to know fully where it would be useful.

Mr. HICKS. I will answer it now in another way: "What is the eastern limit of the arid region?"

The CHAIRMAN. What I want to know is where the division line is, if there be one, between poverty and comfort, without irrigation?

Mr. HICKS. I would rather answer it in the form in which I put it, "What is the eastern limit of the arid region?" My conviction is that so far as you can define the eastern limit of the arid region by mathematical lines the boundary is the one hundredth meridian.

The CHAIRMAN. In Nebraska?

Mr. HICKS. Yes, in Nebraska. I would limit it a little more yet. I would say in central Nebraska. In central Nebraska the one hundredth meridian is the limit. For instance, in Custer County the one hundredth meridian runs right through the western part of that county. Good crops can be raised in central Nebraska up to the one hundredth meridian, and very fair crops in some districts even west of the meridian. Custer County is crossed by the one hundredth meridian, cutting off about two tiers of townships from the west line.

The CHAIRMAN. To what meridian does Custer County extend eastward?

Mr. HICKS. It extends east to about 99° 30′, and that county which lies there mainly between the ninety-ninth and the one hundredth meridian extending over west of the one hundredth meridian took the first premium for county exhibits at the State Fair of Nebraska which has just closed.

The CHAIRMAN. Do you know where those exhibits were obtained; in what portion of the county?

Mr. HICKS. Somebody here will be better able to give you that information, but I will say that in regard to the character of Custer County it is in the Loup River country. Several Loup rivers pass through it, and along those rivers the bottom-lands generally are sandy and poor. The good land is on the divides between the rivers. These divides or table-lands between the rivers occupy by far the greater portion of the county. It was on these divides that the crops were raised that took first premium and therefore upon land which is the prevailing and characteristic land of Custer County and not upon select patches of remarkable fertility, or upon land any more fertile than the rest of the county. So that it is not like the case of crops raised in some particular portion of the county which was a great deal more fertile than the rest.

The CHAIRMAN. Do you know whether that county has had uniform crops for a series of years?

Mr. HICKS. Custer County is new; the oldest lands in that county (those that have been plowed the longest) have probably not been

plowed more than five years, and during that time the yield has been uniformly good. The first plowing of those lands does not yield the best crops as it does in other parts of the country.

The CHAIRMAN. Are you familiar with Brown County? If so, what can you say as to the land there?

Mr. HICKS. The land in Brown County is not very good.

The CHAIRMAN. How is it situated as to rain fall?

Mr. HICKS. The rain-fall is not perhaps quite so great, because the lines of greatest rain-fall do not pursue mathematically straight courses, but make curves. The line of greatest rain-fall would be something like this [indicating upon the map].

The CHAIRMAN. Commencing at the southeast corner of Harlan County?

Mr. HICKS. Yes, and passing out here to the one hundredth meridian and curving off.

The CHAIRMAN. Commencing at the southeast corner of Harlan and then going in a northwesterly direction, crossing the Platte River at the western part of Dawson, and then continuing north to Custer and Brown about on the one hundredth meridian, and when it strikes Brown it would then be a sharp angle to the east through the corner of Brown and Holt up into Knox County and to the Missouri River. That would be about the line of equal precipitation, according to your observation?

Mr. HICKS. Yes; and therefore the boundary of the arid region would not be the mathematical line of the one hundredth meridian according to my opinion, but the line of equal precipitation would be a curve and not a straight line. Westward of that line irrigation is needed.

The CHAIRMAN. Is it a necessity?

Mr. HICKS. It is not an absolute necessity in many portions.

The CHAIRMAN. Is it a necessity to general prosperity?

Mr. HICKS. Yes; it is a necessity to general prosperity and highly advantageous for the certainty and the greatness of the yield which would result from irrigation—the certainty of a production of a fair crop and a greatly increased yield per acre.

The CHAIRMAN. About what proportion of the State would that take—about one-half of it?

Mr. HICKS. Something more than one-half.

The CHAIRMAN. Then something more than one-half is in the arid belt?

Mr. HICKS. Yes; about one twenty-fifth of the whole arid region of the United States is in Nebraska. I want to emphasize that fact to this committee, that Nebraska is entitled to attention in this matter, and we are very glad that you came here to Nebraska to look into the subject.

The CHAIRMAN. In addition to the large ditch that you have suggested, what other modes would you suggest for supplying this arid region with water?

Mr. HICKS. Before leaving the question of the large ditch north of the North Platte I want to say that the water can be taken out on the divide south of the North Platte also. I say that particularly for the benefit of people who are interested on the south side of the North Platte rather than on the north side. Your inquiry now is with respect to additional methods.

The CHAIRMAN. What other streams or means beside the North Platte could be used for irrigation?

Mr. HICKS. It would take me a long while to detail them.

The CHAIRMAN. I do not want them in detail. How is it in regard to the Niobrara; is that useful?

Mr. HICKS. Yes; I will speak somewhat fully of the Niobrara with your permission, and then more briefly as to the other streams, because what I say of the Niobrara will apply to many others. The Niobrara River carries quite a large volume of water. I never gauged it low down, but away up here in this region—in the northwest corner of the State—I found about 125 cubic feet per second.

The CHAIRMAN. At what season of the year?

Mr. HICKS. About this time of the year two years ago, at nearly the driest part of the year.

The CHAIRMAN. How is it about the wettest parts of the year?

Mr. HICKS. I never gauged it then, but I know it carries an immense volume of water.

The CHAIRMAN. Has it been utilized at all for irrigation?

Mr. HICKS. Not to my knowledge.

The CHAIRMAN. What is the character of the country along the Niobrara on both sides? That river would irrigate some lands in Dakota, would it not?

Mr. HICKS. Near the north part of Cherry County it might possibly be used in Dakota, but there is a great body of land which might be irrigated by the Niobrara River in Nebraska—in that portion of it which lies in Cherry, Sheridan, Dawson, and Sioux Counties. Below that, for instance in Brown County, the Niobrara River flows in a cañon, and can not be used.

The CHAIRMAN. You would have to rely on the Platte and the smaller streams.

Mr. HICKS. Yes, but below the Platte the facilities of the Niobrara River are excellent.

The CHAIRMAN. What is the character of the land and the topography?

Mr. HICKS. The land there lies sloping up with a gradual slope from the Niobrara River on both sides all through the counties I name, so that the water taken up by ditch upon that slope could be used between the ditch and the river with the greatest possible efficacy.

The CHAIRMAN. What is the grade or fall of the river?

Mr. HICKS. The Niobrara has a much steeper grade than the Platte. It is a smaller river, and would be expected to have a steeper grade. The characteristic of the Platte River is its remarkable gradient. For a medium sized or small stream the Niobrara River is remarkable for having a high gradient. I will remind you of the French name of the Niobrara River as you have seen it on the old maps, *L'eau qui cour*, the water that runs. The swiftness of the stream so impressed itself upon the French *voyageurs* that they called it "The water that runs." That of course depends on the grade. It has a high gradient and low banks. The water can be easily taken out. The land lies favorably, and in every respect it is an excellent stream for irrigation.

The CHAIRMAN. In addition to that, the different forks of the Loup extend up into Brown, Cherry, and Holt. Can the waters of the Loup be utilized?

Mr. HICKS. Undoubtedly. They are good streams for irrigation.

The CHAIRMAN. Into what does the White River discharge its water?

Mr. HICKS. Into the Missouri in Dakota.

The CHAIRMAN. What kind of a stream is it?

Mr. HICKS. The White River is not so good in irrigation time as the

Niobrara. Some of its tributaries for small streams are excellent. The White River, however, in the main stream is not so good a stream for irrigation. But on the whole, taking the Upper White River and the tributaries of the White, there is a large body of land in upper Nebraska which could be irrigated. A stream which is one of the very best in the State of Nebraska for irrigation is the Republican River and its tributaries.

The CHAIRMAN. Where is that?

Mr. HICKS. In the southwestern part of Nebraska. As far east as irrigation is needed the Republican River is a source of much water for irrigation.

The CHAIRMAN. In what State does the Republican River rise?

Mr. HICKS. In Colorado, but very near the State line. It flows into Kansas. The Republican, therefore, is a Nebraska river. It is not a mountain stream. It rises on the plains not far from the Nebraska line in Colorado.

The CHAIRMAN. Does it carry water in the dry season?

Mr. HICKS. A great volume of it. I gauged it in Furnas County and found 570 cubic feet.

The CHAIRMAN. What is your theory as to the remarkable supply of water in the Republican—it does not come from the immediate rain-fall does it?

Mr. HICKS. I am not able to say with any positiveness that there is any other important source.

The CHAIRMAN. I have heard it suggested that it was probably supplied from underground water; water that was passing through Colorado under ground.

Mr. HICKS. I think it is probable. Observe what I said, that I am not able with any positiveness to ascribe any other source for the water of the Republican but the rain-fall of the region which it drains. I know that the rain-fall on the Republican basin furnishes most of the water that runs into the Republican. Whether there is any other source of any considerable importance (while I think it highly probable) I do not know any facts that would give me any means of making a positive statement.

The CHAIRMAN. A considerable country could be irrigated by that?

Mr. HICKS. A very great area could be irrigated by the Republican and its tributaries. While I described the land along the Niobrara as lying favorably for irrigation, I think that I could speak with more emphasis still of the land of the Republican. It lies admirably to receive the water.

The CHAIRMAN. As to the South Platte; you have about 80 miles of that in Nebraska. Can a supply be obtained from that; and, if so, how? You have already explained that, by natural process, if the water is stored above, so that it will fill the soil, it will naturally work along down and finally benefit Nebraska; but, not waiting for that, is it possible to take out the water from the South Fork?

Mr. HICKS. I do not want to monopolize the business of giving information to this committee; and, while I might have something to say on that point, the engineer who is now constructing a ditch to take out the water of the South Platte, in this immediate locality is here, and I should like you to ask him that question.

The CHAIRMAN. I wish you would speak at greater length of the storm-water and the facilities for utilizing it in Nebraska generally, according to your observation, by reservoirs?

Mr. HICKS. Do you mean the flood-waters of the streams, or the precipitation upon the general surface?

The CHAIRMAN. Upon the general surface, in the ravines and small streams in the highest portion of the State—anywhere where it could be done without regard to streams. How much of an aid will that storm-water, kept in small ponds and reservoirs, be?

Mr. HICKS. In my judgment it will be of the utmost value; while, compared with many parts of the earth the rain-fall over this region is what you would call light, still, the aggregate of water falling on say a square mile of land in this region, supposing the rain-fall to be 15 inches, can be easily computed; and any one who makes the computation will be astonished at the amount of rain-fall that reaches the land. If the waters that fall on the surface here were collected in small reservoirs, such as might be constructed at moderate expense by individual owners on their own lands, and for the construction of which the topography is favorable, an immense area might be irrigated from these storm-waters.

The CHAIRMAN. How much water do you require in addition to the rain-fall generally in western Nebraska to produce all-around crops? Have you given that particular subject any consideration?

Mr. HICKS. I am not prepared to answer that question definitely as to quantity. I could, however, make an estimate in general terms.

The CHAIRMAN. Do so.

Mr. HICKS. In my judgment, through a large part of the area west of the curve which I have already indicated, the rain-fall and the climatic conditions generally are such that the amount of the artificial aid required from irrigation is comparatively small. For instance, in Colorado it requires 12 inches of water each year on the irrigated fields to produce crops, while, I should say, that in some parts of Nebraska, 2 inches ould be enough, in other parts 3, and in other parts 5, and so on, according to the proximity to this line that I have indicated. Further west, you must have a greater number of inches and during a greater length of time. In many parts west of the line I indicated, if water could be put upon the land only for a few days at a critical time, it would save the crop and make a good crop. So that the amount required varies with the location, and with many local conditions and circumstances. But generally my answer would be, that the amount required is not more than one-third of full irrigation in a great part of this region.

The CHAIRMAN. What effect in Nebraska does thorough cultivation have upon the moisture?

Mr. HICKS. It has the effect of retaining that which falls from the heavens, and of attracting more moisture from the atmosphere in the form of dews, and also probably, locally, in the form of rain. I do not consider it an established fact that the rain-fall of Nebraska is increasing.

The CHAIRMAN. Is it generally supposed that rain-fall is increasing?

Mr. HICKS. Yes; it is generally supposed that it is, and that the rain-fall is traveling westward. As I say, I do not regard that as an established fact; but, owing to the conservation of the moisture in the soil, resulting from cultivation and the protection of the surface by the vegetation that grows upon it, its protection from the heat of the sun's rays, so that it does not become so intensely hot, and so that it does not immediately discharge the water put upon it, the effect of cultivation is manifest. As to the increase of moisture, it comes principally in the form of dew. In the great plains it was often stated and believed by many that there was no dew. In all this region, wherever crops are cultivated, if you go into a field of wheat, oats, barley, or tall grass in

the evening you will get your feet wet, and you will find plenty of dew, Where the soil is cultivated and where vegetation is growing there is dew. The reason why there was no dew before cultivation is that the surface, baked by the sun's rays during the day, becomes so intensely hot that at no hour of the night did it become much colder than the air; and the precipitation of dew depends on the condition of a difference between the temperature of the objects which receive the dew (the lower temperature of the earth or of the plants on which the dew collects), than the temperature of the surrounding air. When the surface is protected by vegetation the earth itself does not become so hot—is not so intensely heated by the rays of the sun—and the plants stretching up into the air from the surface of the earth are so situated as to lose their heat rapidly by radiation. As soon as the sun goes down in the evening they begin to cool off, and speedily become colder than the circumambient atmosphere, and in that way form dew. Thus, without any increase in rain-fall, but by the increase in the dew-fall, or the conservation of dew, we have, as a practical result of breaking the surface of the soil, what is the same in effect as if there had been an increase in rain-fall.

The CHAIRMAN. There is another question which I wish to ask you: It has been suggested that by the cultivation of the soil and the production of vegetation over a large surface the rain-fall is equalized and is not so spasmodic and erratic so far as concerns its falling all in a body in a single place as in the case of a cloud-burst. Have you observed in Nebraska any effect of that kind?

Mr. HICKS. Nebraska at present is not afflicted with sudden bursts like that.

The CHAIRMAN. That is, the cultivated portion of it?

Mr. HICKS. The cultivated portion of it. Whether that is due to the cultivation, and whether storms were formerly more spamodic here I am not prepared to answer.

The CHAIRMAN. You have not lived here long enough and observed the changes so that you could not say whether that is a fact or not?

Mr. HICKS. I could not say personally whether it is or not.

The CHAIRMAN. How are rains in this part of Nebraska; do they form cloud-bursts in places, or do they fall pretty evenly over the whole surface?

Mr. HICKS. There are not many "cloud bursts," but there are many local storms.

Director POWELL. What would you suggest as the line of investigation for the arid region of Nebraska?

Mr. HICKS. I believe that the scientific study of the special characteristics of this whole region, pursued long enough and thoroughly enough to give systematic and tolerably complete results, is the proper method of procedure, and in fact the only method, regarding this region as a whole, and that may be done most economically under the authority of the General Government. If it is not so done it must be done at the expense of communities, corporations, or individuals, in a spasmodic, irregular, incomplete, and often inaccurate and inadequate manner; whereas a general survey of this whole region would be in the hands of the most skillful engineers who would present the subject in its completeness and in all its connections, and would be far more valuable in any given locality, so far as it pertains to that locality than if the most thorough survey of that locality had been made by itself.

As to the method of doing that, it seems to me that this region demands a line of investigation different from any other. And when

speak of this region I do not simply mean this portion of Nebraska, or this county, or even this belt of Nebraska in which we now are, or of which I have been speaking, but the whole belt that lies approximately in the same meridian—a belt of one, two or three hundred miles in width, which lies upon the margin of the arid regions, where physical conditions are so different from those which prevail in the mountainous districts that a different line of investigation must be pursued, and a line of investigation which in some respects must be more costly and elaborate than would be required in the mountain regions. There ought to be a great deal of attention given to this region in this Irrigation Survey, and money ought to be expended upon it without stint, all that is necessary to bring out the best possible results.

The reason why it is going to be a more costly survey in this region than in some other parts of the arid regions, is that the streams are inadequate to water this region. While I have described a number of streams for irrigation, I believe I have said nothing beyond what the facts will bear out in regard to the value of those streams; yet, taking them altogether, they are inadequate to the demands of this region for irrigation. You can not get the water out of all the streams in Nebraska to water all the lands that need water here. Nebraska is so happily situated, and its physical condition is so happily adjusted in respect to the character of the surface, that there are very few acres of all this region that are not good arable land. Of all this region that needs irrigation the percentage of it which would not kindly respond to the efforts of the irrigator and farmer is very small, indeed—remarkably so as compared with other regions. We have no mountain ranges. We have a few sand-hills and other places that can not be irrigated. But I suppose the amount of arable land in Nebraska is one-half the land of the State; that is, we will say in round numbers, 40,000 square miles. There is, I should say, not more than 5,000 square miles of that that would not respond to operations to redeem it. We will say there are 35,000 square miles, then, that are suitable to receive the water.

The water of the storms is insufficient to supply that body of land, and therefore the storm waters must be stored in numerous little reservoirs all over the country. To find the places for these numerous little reservoirs, to ascertain the configuration of the surface, and to "place" those reservoirs will take careful and accurate work. In my judgment, the Irrigation Survey should proceed upon those lines in this region to indicate by their careful work where those reservoirs can be constructed, not only how the streams may be used, but how the storm-waters which fall upon the general surface of the country and run off can be saved up and made to water the largest amount of land. In general, that would be my notion of what an Irrigation Survey ought to be for this belt.

The CHAIRMAN. Have you any artesian water any where in the State?

Mr. HICKS. Yes.

The CHAIRMAN. You are aware of the existence of a belt of artesian water in the two Dakotas. Is the artesian water of Nebraska good water?

Mr. HICKS. Yes; the best I ever saw. The belt runs somewhat west of north. That belt strikes Nebraska. In Knox County there is excellent artesian water to be found and at very moderate expense, but it is not in the belt that needs it. That artesian water is going to be of great value for power, if for nothing else. You can get a great water-power by boring into the earth. In the western region, where irrigation is most needed, the results of exploration for deep artesian waters have so far been n[illegible].

The CHAIRMAN. How deep have they bored in any one place in the western part of the State?

Mr. HICKS. I do not know exactly as to that. No very deep wells have been bored in this region.

The CHAIRMAN. Have any of them kept a record of the conformation in the case of those wells that have been found?

Mr. HICKS. I have no record of wells in this region of greater depth than 500 feet.

The CHAIRMAN. Are there any portions of Nebraska where the water is near enough to the surface to make the use of pumping machinery cheap enough to be practiced to any extent?

Mr. HICKS. I think there are.

The CHAIRMAN. In what portions of the State is the water near the surface?

Mr. HICKS. I might adduce the facts that have come to your own notice as we traveled along this section. The water is standing on the surface in some places as we came along, and I have been informed that here at Ogallalla the water is only three feet from the surface.

Near the headwaters of the Loup River the water lies very near the surface. In many parts there are salt lakes. The water collects in the depressions and makes little salt lakes. In the sand-hills (all things considered the least valuable of all), there are small lakes and the water generally lies near the surface (I do not mean the summit of a sharp peak of a sand-hill), but you can get water and it is remarkable how near the surface you can get it. Wherever there are depressions the water lies very near the surface for wells.

The CHAIRMAN. May not the fact that the water lies near the surface on the Loup and other rivers have something to do with the production of crops there and with extending the belt?

Mr. HICKS. That is an explanation of the productiveness of that region but you would have to go farther to show that the water is there.

The CHAIRMAN. The water is there. It would be increased by additional rain-fall but the water is on the surface. What is the price of coal in this town?

Mr. HICKS. Some gentlemen living in Ogallalla can tell that better than I.

Mr. NEEVES. We do not get it very cheap. We pay $7 a ton for it.

STATEMENT OF ROBERT B. HOWELL, OF OMAHA.

The CHAIRMAN. What is your occupation?

Mr. HOWELL. I practice engineering.

The CHAIRMAN. In what engineering enterprise are you now engaged?

Mr. HOWELL. In hydraulic engineering. We are considering the construction of a canal here in Ogallala.

The CHAIRMAN. From what stream and to cover what land?

Mr. HOWELL. From the South Platte River to cover the land lying between the town of Brewell, about 10 miles above here, and this town.

The CHAIRMAN. How do you expect to get the water out of the Platte?

Mr. HOWELL. By seepage from the sand.

The CHAIRMAN. How are you going to get seepage?

Mr. HOWELL. *Either* by digging a drainage ditch or by means of *galleries.*

The CHAIRMAN. Explain how you would do it.

Mr. HOWELL. The gallery would be a wooden structure made of wood scantling and made in the rectangular form, and placed on the hard pan to form a sort of sewer as it were to carry off the drainage of the sand. This would be laid down and the water led off the pipe. The river falls at the rate of 8 feet to the mile. The pipe would be laid out about 2 feet to the mile.

The CHAIRMAN You would go into the sands and sink these galleries to form a body of water, and you would draw that water off by means of pipes and by gravitation with sufficient grade until you got it so that you could turn it into a ditch?

Mr. HOWELL. Yes.

The CHAIRMAN. Have you prospected the river to find out how much water there is below the surface? What means have you taken to ascertain that?

Mr. HOWELL. No means. We have examined and know that the stratum is about 18 feet. By digging anywhere from 6 to 18 inches below the surface the water fills up the cavity.

The CHAIRMAN. How wide does the water flow near the surface?

Mr. HOWELL. At this point it flows across the whole surface of the river.

The CHAIRMAN. About how wide is that?

Mr. HOWELL. About 3,000 feet at some places.

The CHAIRMAN. Does it also flow beneath the surface in the low bottoms?

Mr. HOWELL. Yes. The water seems to be higher in borings that are made below the river bank than in the river itself.

The CHAIRMAN. For some distance from the river on either side this water is as wide as the river bed?

Mr. HOWELL. Yes, it seems to be a little wider.

The CHAIRMAN. How wide at this place is the bottom where you can get the water?

Mr. HOWELL. For three-quarters of a mile on each side of the river you could get water for a distance of about 30 miles, I should think, at the highest point.

The CHAIRMAN. Is it not best to make a ditch deep in proportion to the width?

Mr. HOWELL. Yes, the theoretical form for a ditch is a deep ditch.

The CHAIRMAN. The practice in Colorado and this country seems to be to make a shallow ditch. Do you agree with that practice as to the economical preservation of the water?

Mr. HOWELL. No; I think a deeper ditch would be the best, but deeper ditches are more expensive, and it is only in cases of high water that they would carry a maximum amount.

The CHAIRMAN. How far up the river are you going to take out this ditch?

Mr. HOWELL. About 12 miles.

The CHAIRMAN. Are you going to continue it a considerable way down.

Mr. HOWELL. No, we are going to stop at this point.

The CHAIRMAN. There is land below to which it may be carried down if you should wish, is there not?

Mr. HOWELL. Yes.

The CHAIRMAN. Is it possible to get the water of the South Platte, commencing in Nebraska, onto the table-land?

Mr. HOWELL. Yes, that can be done.

The CHAIRMAN. Beginning in Nebraska and extending up and down?

Mr. HOWELL. Yes, I think it can, without doubt.

The CHAIRMAN. Are there any places in the river between here and the mountains where there is rock formation to bring the water to the surface?

Mr. HOWELL. Yes; there is one place that I know of.

The CHAIRNAN. How far up is that?

Mr. HOWELL. Near Fort Morgan.

The CHAIRMAN. How much water runs in the river at that point?

Mr. HOWELL. About 122 cubic feet per second, but the rock is only exposed on one side. Over that rocky place there are 122 cubic feet per second running.

The CHAIRMAN. You do not know what the inclination of the rock is on the other side of the river?

Mr. HOWELL. No.

The CHAIRMAN. Or whether the rock rises again so as to form a dam—that has not been prospected?

Mr. HOWELL. No. In Colorado they are constructing a canal to take the water out, and there is a point above where a dam has been constructed across the river, from bed-rock to the surface, to force the water in the river to the surface.

The CHAIRMAN. It follows the bed-rock?

Mr. HOWELL. Yes.

The CHAIRMAN. How much water does that force to the surface in ordinary times?

Mr. HOWELL. The gentleman who constructed it calculated that it was 100 cubic feet per second that was running through the canal, but there was some being lost at the same time going down the river.

The CHAIRMAN. The dam did not stop it all?

Mr. HOWELL. No. The dam was just up to the surface of the sand

The CHAIRMAN. How far is that from the State line?

Mr. HOWELL. That was at Fort Morgan. I do not know exactly where it is. It is beyond Sterling.

The CHAIRMAN. How long a ditch have they run from that down?

Mr. HOWELL. I think it is about the neighborhood of 64 miles altogether.

The CHAIRMAN. It is getting down pretty well to the State line?

Mr. HOWELL. No. The main or supply ditch follows the contour of the surface and there is a lateral. Altogether, I think, it is 64 miles long.

The CHAIRMAN. On which side of the river is it taken out?

Mr. HOWELL. On the south side.

The CHAIRMAN. Why would it not be a good plan to unite with those people and take out all the water and bring it down as far as it will come?

Mr. HOWELL. Because 122 feet per second would be insufficient.

The CHAIRMAN. But in flood-time there is a good deal more?

Mr. HOWELL. Yes; but they have not practiced much the saving of water in winter.

The CHAIRMAN. Water saved in winter is just as good as that saved at any other time, is it not?

Mr. HOWELL. Yes.

The CHAIRMAN. Suppose you make reservoirs along on the highest points, could you not irrigate a good deal of your land in that way?

Mr. HOWELL. Yes; not only there, but upon the tables. There are

many natural reservoirs where water might be stored, and, although it could not be used for irrigating, it could be left there to temper the winds.

The CHAIRMAN. But it could be stored and used for irrigation when wanted.

Mr. HOWELL. It might. If you could not get the water on the land to irrigate, it would be good to let it stand around in small lakes.

The CHAIRMAN. Taking the river out at the point where the rocks appear, what would be the lay of the land, of the topography, from there down?

Mr. HOWELL. There is a gradual slope to the river. The slope ends at the table-land above.

The CHAIRMAN. How does the land on the South Platte along here by Fort Morgan and Sterling compare with the land on the other side as regards its natural fertility?

Mr. HOWELL. The soil seems to be sandy about Fort Morgan.

The CHAIRMAN. On which side?

Mr. HOWELL. On the south side.

The CHAIRMAN. Much more so than on the north side?

Mr. HOWELL. Yes.

The CHAIRMAN. Is that true all along for a considerable distance that this is really somewhat of a sand-hill region on the south side?

Mr. HOWELL. I think it is.

The CHAIRMAN. Are there any other views you wish to present?

Mr. HOWELL. There is one point which I think is a good one, that is, to make a series of reservoirs or lakes on the table-lands, using the spring water. Although the water can not in many cases be used to irrigate land, at the same time it would be making innumerable lakes which would increase evaporation and dew. Whether it would have any effect on the rain-fall is uncertain.

The CHAIRMAN. Can you get reservoirs and use the storm water?

Mr. HOWELL. I think the storm water is all held there now. I think there is only one draw that extends up to the table-land between here and Grant, about twenty miles south of this. It does not seem that any great quantity of water ever passes at that draw.

The CHAIRMAN. Is there a lake there?

Mr. HOWELL. No. There is sort of dry lake but the water is stored in the shallow lakes until about this time. Then evaporation takes the greater portion of it. There are wells there 200 feet deep and the strata there are ordinarily pervious to a great extent.

STATEMENT OF C. H. BROWN, OF KEITH COUNTY.

The CHAIRMAN. How far from this town is your county?

Mr. BROWN. Seven miles southeast.

The CHAIRMAN. What is the character of the county on the other side of the river?

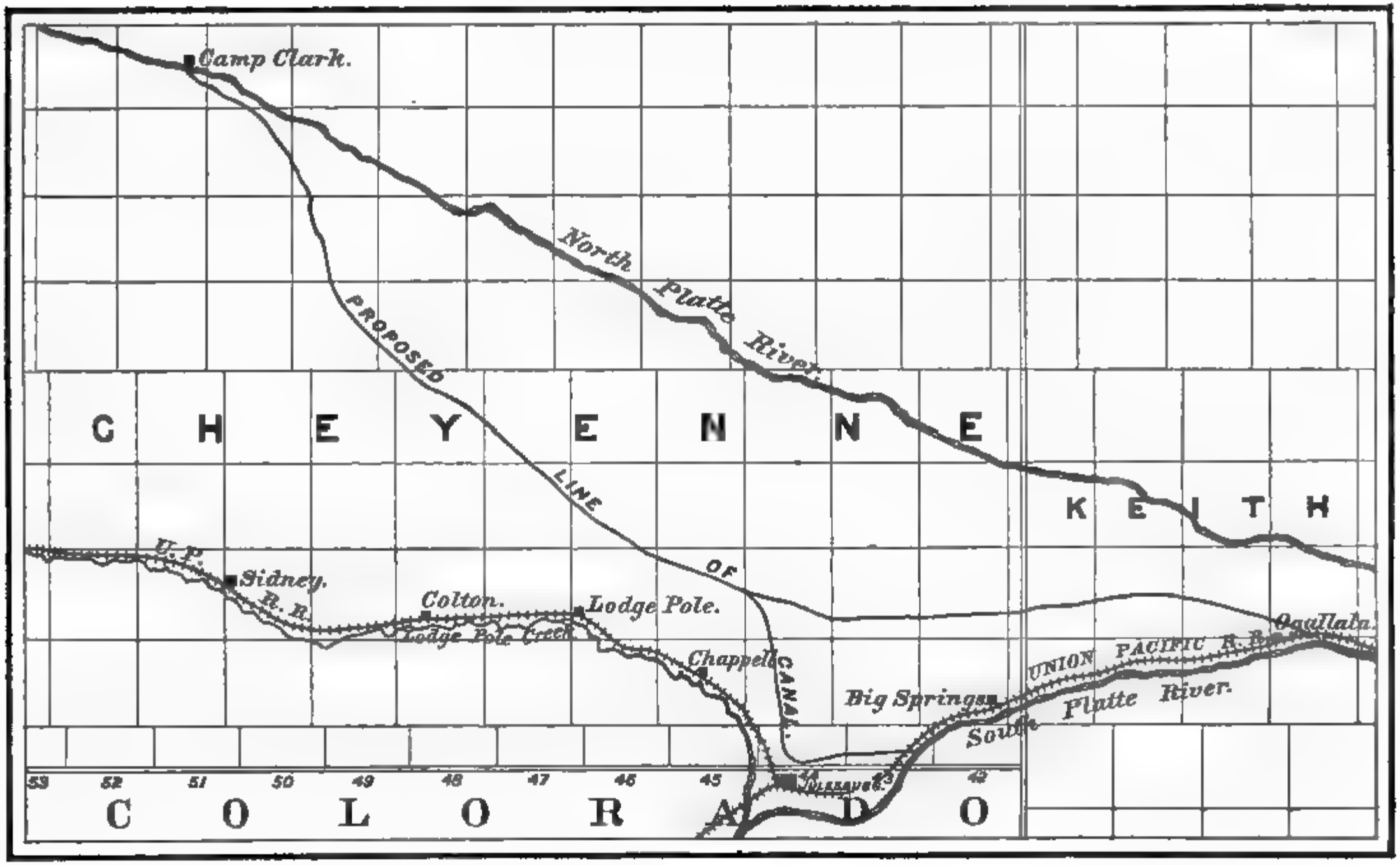
Mr. BROWN. It is very level and smooth. It has a fine soil. It is also indented with what are called in this country lagoons. You will find a lagoon on an average to a quarter section and from that more. Those lagoons in extent will run up from 4 acres to 160.

The CHAIRMAN. Does much water collect in those during the storms?

Mr. BROWN. Some seasons they have been partly filled with water but never full.

The CHAIRMAN. Do they discharge the water into the Platte?

MAP OF A PORTION OF CHEYENNE AND KEITH COUNTIES, NEBRASKA.



Mr. Brown. But very little.

The CHAIRMAN. They have no outlet?

Mr. BROWN. No.

The CHAIRMAN. There are depressions in the earth.

Mr. BROWN. Yes. There is not water enough falling to overrun these lagoons at any time.

The CHAIRMAN. Can you not build a dam across them and make a pond?

Mr. BROWN. There are already ponds.

The CHAIRMAN. But you say they are so low that you can not get the water to use?

Mr. BROWN. In some places. Some of them are too low, and you can not drain them on to the land, but others on the high points could be used for irrigation. There are several ridges of land that are a little higher than the balance, and those ridges generally have the most lagoons.

The CHAIRMAN. The lagoons are almost too large to make ponds of, are they not? You do not have water enough to fill them?

Mr. BROWN. We never have had them all filled in the six years that I have been here.

The CHAIRMAN. Could you not make ponds or small lakes and fill them?

Mr. BROWN. We could if we had the water.

The CHAIRMAN. Some water comes down I suppose?

Mr. BROWN. Yes.

The CHAIRMAN. How is the lay of the land between the Republican River and the Platte?

Mr. BROWN. There is a natural fall to the south.

The CHAIRMAN. And there are table-lands extending along between the Republican and the Platte, are there?

Mr. BROWN. Yes.

The CHAIRMAN. About what elevation is there above the Platte?

Mr. BROWN. About 200 feet from the water-bed. That is about the depth of our wells—from 150 to 200 feet.

The CHAIRMAN. Is it good land?

Mr. BROWN. The nicest I ever saw.

The CHAIRMAN. Do you raise regular crops there without irrigation?

Mr. BROWN. No.

The CHAIRMAN. Can a farmer prosper there without irrigation?

Mr. BROWN. No.

The CHAIRMAN. It is not a good place for homes, then, without irrigation?

Mr. BROWN. No.

The CHAIRMAN. Have you tried it thoroughly to ascertain?

Mr. BROWN. I have tried it for six years.

The CHAIRMAN. Do you know anybody who knows it any longer than you do?

Mr. BROWN. No. I plowed the first acre of land that was plowed in this country.

The CHAIRMAN. And during the six years' experience you have come to the conclusion that it will not do to try to farm without irrigation?

Mr. BROWN. I have.

The CHAIRMAN. Is that the experience of your neighbors?

Mr. HOWELL. Yes, as far as I know.

The CHAIRMAN. You came here under the expectation that you could do it?

Mr. BROWN. Yes.

The CHAIRMAN. And you have been disappointed?

Mr. BROWN. Yes. Some years we have raised a particularly good crop and some years nothing. This year we have nothing at all as far as corn goes, though we have a middling fair crop of wheat and a partial crop of rye.

STATEMENT OF W. L. GOULD, OF OGALALLA.

The CHAIRMAN. How long have you resided here?

Mr. GOULD. About three years.

The CHAIRMAN. You may state anything that occurs to you in reference to storm-water and other water for irrigation.

Mr. GOULD. My experience has been this, that when we have abundance of rain through the winter, enough to soak up the ground well, there is no trouble about certain classes of crops growing; but if we have a dry winter we are apt to have a dry spring following, and not sufficient rains to grow crops. I know this, that in these table lands between the two rivers nature has provided a number of places, if utilized, to fill up with an abundance of water during the winter, which could be utilized during the summer. I have driven extensively over the country.

The CHAIRMAN. You think reservoirs would be filled if they were made?

Mr. GOULD. Yes.

The CHAIRMAN. Have there been any experiments made here to show what reservoirs can do?

Mr. GOULD. We have seen farmers who have built dams on small streams and have used that water for irrigation on whatever surface was below, and with good results.

STATEMENT OF FRANCIS M. SMITH, OF OGALALLA.

The CHAIRMAN. Where do you reside?

Mr. SMITH. In Ogalalla.

The CHAIRMAN. Are you a farmer?

Mr. SMITH. I have had experience in farming this season.

The CHAIRMAN. Have you ever constructed a reservoir here to save water?

Mr. SMITH. Yes, we constructed an irrigating ditch, and have been using the water this season, and it has been successful.

The CHAIRMAN. Give us some information as to it.

Mr. SMITH. We have our farm over on the north side of the North Platte River, about 15 miles northwest of this. There is a small stream called Sand Creek running a couple of miles on our property. My experience is that, in this section of country, farming is unsuccessful. I have never seen a full crop grown yet for the three years that I have been here. We went to work and constructed a dam across this stream and put in a canal for a distance of about 3 miles (myself and my neighbor), and we have been using the water on 40 acres of ground that we broke this spring. We put that to corn, and it is a very heavy piece of corn. We consider it a full crop. My neighbor also uses it on 40 or 50 acres, and he got a good crop. Where the water failed to reach the crop the corn was a failure.

The CHAIRMAN. How much water did you store by your dam?
Mr. SMITH. I think we have about 1,400 cubic inches.
The CHAIRMAN. Per second or what?
Mr. SMITH. All the time.
The CHAIRMAN. Does the stream furnish that, or did you increase it by your dam?
Mr. SMITH. We increased it by the dam. We turned the stream.
The CHAIRMAN. Did you make a lake?
Mr. SMITH. No, we did not mean to make a lake. We live on the bottom, on the north side of the river, in the valley, and we constructed a dam there and turned the stream simply.
The CHAIRMAN. How is that stream in winter?
Mr. SMITH. There appears to be just as much water there in winter as in summer.
The CHAIRMAN. If you had a reservoir in there, so that you could save that water the year round, you could do a good deal more, could you not?
Mr. SMITH. Perhaps so, but we use it as it is to irrigate about 80 acres.
Director POWELL. What did you mean by 1,400 inches of water?
Mr. SMITH. That would mean 1,400 inches of solid water; what the ditch would carry.
Director POWELL. In how much time?
Mr. SMITH. It would carry that by the minute or second, just as it would run.
Director POWELL. Have you ever mined?
Mr. SMITH. No, I never did mine.
Director POWELL. You do not know what a miner's inch is?
Mr. SMITH. No.
Director POWELL. How wide is your ditch?
Mr. SMITH. I think it is about 3 feet in the bottom.
Director POWELL. And how deep does the water run?
Mr. SMITH. I hardly know the depth. We have never measured it, but when we filed our right under the irrigating law there were men who appeared to understand the nature of irrigation that we consulted, and they said that there were about 1,400 cubic inches of water in that stream.

STATEMENT OF J. J. McINTOSH, OF SIDNEY.

The CHAIRMAN. Do you require to irrigate your land in order to produce crops?
Mr. MCINTOSH. We irrigate there as much as we can. Irrigation is not carried on there, however, to any very great extent.
The CHAIRMAN. Could you produce crops there without irrigation?
Mr. MCINTOSH. No, not a full crop.
The CHAIRMAN. What efforts have been made to irrigate there, and what are the chances to irrigate?
Mr. MCINTOSH. The chances are good to irrigate there, as stated by Professor Hicks. There was no attempt to do any farming there until the year 1884. The people that came there to settle came with the understanding that irrigation was not required, and it was not expected at all that people would have to irrigate. They supposed that there was sufficient rain-fall to produce a fair crop after the land was properly tilled. But many settlers came in and many went away, and at no time since then have they succeeded in raising a full crop of anything. That

is about the truth of the matter in few words. I have lived in that county on and off since 1870.

The CHAIRMAN. They have irrigated some in your county, have they not?

Mr. MCINTOSH. They have irrigated some along the Lodge Pole.

The CHAIRMAN. What have been the results of irrigation there?

Mr. MCINTOSH. When they have irrigated the results have been very satisfactory.

The CHAIRMAN. What are the facilities for irrigation?

Mr. MCINTOSH. The facilities are good there.

The CHAIRMAN. The Lodge Pole furnishes some water, I suppose.

Mr. MCINTOSH. Yes.

The CHAIRMAN. Does it have floods?

Mr. MCINTOSH. We have heavy rain-falls there. Our rain-falls are more spasmodic than the rain-falls in the center or eastern part of the State.

The CHAIRMAN. The water runs to waste then considerably, does it?

Mr. MCINTOSH. Yes.

The CHAIRMAN. If that water was stored in proper places would the Lodge Pole furnish any considerable amount of water for irrigating the land?

Mr. MCINTOSH. It would furnish enough water to irrigate the valley in which it is. My idea about irrigating the table land between the Lodge Pole and the North Platte River would be to take the water from the North Platte River at some point in Wyoming. Then it can be stored in ravines so as to be used in the valley if necessary.

The CHAIRMAN. Are you familiar with the North Platte?

Mr. MCINTOSH. No.

The CHAIRMAN. You do not know how much of an undertaking that would be?

Mr. MCINTOSH. No; but I have been informed by a practical engineer who went out there about ten days ago, that it is perfectly practicable to take the water out of the North Platte River on to the table land.

The CHAIRMAN. If that were done and the flood waters were saved you could irrigate considerably?

Mr. MCINTOSH. We could irrigate the whole divide.

The CHAIRMAN. What are the opportunities on the divide for storing storm water in the ravines?

Mr. MCINTOSH. There are a number of natural basins on the table-land where water stands the whole season round. I have been all over the table land there.

The CHAIRMAN. These natural basins are not always the best places. Sometimes you could save water better by making your own basin in the ravine. They are apt to have underground communication and leak badly. Besides, you would need to make the places deep or the evaporation would be bad. Are there opportunities to make ponds there so as to have water?

Mr. MCINTOSH. Yes.

The CHAIRMAN. How deep is the water under the surface?

Mr. MCINTOSH. On the table land it varies. It runs from 75 feet to 250.

The CHAIRMAN. How deep is it in the Lodge Pole Valley?

Mr. MCINTOSH. Twenty-three feet in the center of the valley and then as you go back toward the table land the depth is greater.

The CHAIRMAN. Is there much of a flow of the underground water in *the Lodge Pole* at 23 feet?

Mr. McINTOSH. Yes, the wells are inexhaustible.

The CHAIRMAN. Something might be done, perhaps, by pumping there?

Mr. McINTOSH. Yes, I think so.

STATEMENT OF THEODORE MENGES, OF KIMBALL.

The CHAIRMAN. On what stream do you reside?

Mr. MENGES. On the Lodge Pole.

The CHAIRMAN. Has there been any irrigation from the Lodge Pole in your vicinity?

Mr. MENGES. Yes, to some extent.

The CHAIRMAN. With what success?

Mr. MENGES. With the best of success. They have gardened some. They have farmed barley and some oats (60 bushels to the acre). The barley was 35 bushels to the acre. They have got excellent corn and all kinds of vegetables in great abundance.

The CHAIRMAN. What are the opportunities for irrigating on the Lodge Pole in your neighborhood?

Mr. MENGES. They are good.

The CHAIRMAN. How can they be utilized?

Mr. MENGES. By damming the valley.

The CHAIRMAN. Does much water flow in the Lodge Pole at any season of the year?

Mr. MENGES. An average of about 12 cubic feet per second flows on the surface. At Kimball we have been at considerable expense to make surveys to find out how much water we have there, expecting to construct a dam and create a water power. It was estimated by an engineer we had there that we had five times as much water flowing on the surface as flood in the stream itself.

The CHAIRMAN. Is there any opportunity to get that water to the surface?

Mr. MENGES. We have made soundings across the valley, a distance of about 400 feet, and we find that the distance to rock bottom varies from 11 to 17 feet. About from 2 to 3 feet beneath the surface of the soil we come into water, and from there all the way down into the rock. To bring that water to the surface is very desirable, and we believe it can be done by putting down a dam of some sort on this rock bottom and building it up.

The CHAIRMAN. They have not resorted to pumping there at all?

Mr. MENGES. No. We do not know how it is possible even to get down to that rock-bottom. We have sounded with augers but we need to get down so as to make a larger excavation.

The CHAIRMAN. Is there any other possible water supply for you except the Lodge Pole?

Mr. MENGES. That is all, excepting the storm waters. With reference to those storm waters we find these lagoons on the divide, and, as stated by yourself and others, I think they are not the best places for catching these waters. Take the whole of Kimball County and you will find it more or less rolling. We have "draws" there in places varying from 20 to 500 feet. They will sometimes have enough water during these storms to swim a horse across them. I know that passing my house and passing the ranch in which I live there is a place that looks perfectly dry generally. It drains a distance of two miles. We have our heavy freshets in July and August and the water was five and

six feet deep towards the end of July and first of August. Take the town of Kimball and for two or three hours after a heavy storm you could row a boat through its streets. Kimball drains a body of land of two or three townships, I should say, and when the heavy floods come it makes the whole town practically a lake.

The CHAIRMAN. If that water was stored it would do considerable good.

Mr. MENGES. Yes, an immense amount of good.

The CHAIRMAN. Would you regard surveys and examinations as to the best points for designation for reservoirs as desirable?

Mr. MENGES. Very desirable and exceedingly valuable to the people.

The CHAIRMAN. We want to know whether money spent in that way will be useful.

Mr. MENGES. Very useful and it will be very highly appreciated. In the town of Kimball we have been attempting to develop a water-power and have been at an expense of $500 or $600, which demonstrates the desire of the people to have better water facilities.

The CHAIRMAN. What is the fall of the stream?

Mr. MENGES. It is 14.4 feet to the mile.

The CHAIRMAN. Then a mile of a channel or cut would bring you to the level of the bottom of it, will it not?

Mr. MENGES. Yes.

The CHAIRMAN. Then you would not have to build the dam so high?

Mr. MENGES. No, although we get power of course in proportion as we raise the dam. We have made an examination 10 miles westward from the town of Kimball, and we find that the average will be 15 feet to the mile. In some places the fall would be greater than at others. We had intended to take out a canal, and went up 10 miles and found it 15 feet to the mile on an average. Then we made accurate measurement for 5 miles and for that distance it was 14.4 feet to the mile.

The CHAIRMAN. In a couple of miles you would get to bed-rock?

Mr. MENGES. Yes. Immediately west of the town of Kimball you will find the bed-rock and all water flows over the rock itself.

The CHAIRMAN. Why would that not be a good point?

Mr. MENGES. It would be an excellent point, but it would not be at the place where the town wants it.

The CHAIRMAN. Suppose you built your dam there and brought the water through the town by a flume or pipe?

Mr. MENGES. That would do. We want it to make a lake near the town, however, and were willing to put in a little extra expense. In that stream we have 12 to 14 cubic feet to the second. It is supposed that we can have about 25 to 30 by putting this dam down to bed-rock, and possibly more than that. One estimate was that we could have about 60 by putting it down to bed-rock.. If we could save the flood water we would have all the water we wanted for the whole valley and a portion for the divide.

The CHAIRMAN. You could build a dam and save the water by that means. I should build a dam where the rock is and I should have a pipe at the bottom—an iron pipe—cemented in so that you could draw the water out and irrigate a great deal of the land. You would want to draw water off in the summer, would you not, for irrigating purposes?

Mr. MENGES. I think you would not want it all. By taking the North Platte and going 20 or 30 miles into Wyoming, that is a magnificent divide lying between the Lodge Pole and the North Platte. There are 1,500,000 acres that could be utilized and utilized well. There is practically no waste land at all.

The CHAIRMAN. The Platte River is a large river.
Mr. MENGES. Very large.
The CHAIRMAN. A great deal of it runs to waste.
Mr. MENGES. Yes; a great deal of it. In the spring as much as 1½ to 4 feet in depth over a half to three-quarters of a mile was flowing down.

STATEMENT OF J. A. PHILLIPS, OF GRANT.

The CHAIRMAN. Is there any stream of water in your county?
Mr. PHILLIPS. No; the nearest stream of water we have is 20 miles away. I live 20 miles south of this.
The CHAIRMAN. How would you suggest that this section might be redeemed by irrigation?
Mr. PHILLIPS. We would like to have a ditch commence in Colorado, 20 miles from the Nebraska line.
The CHAIRMAN. Is there any place at which you could get the water out?
Mr. PHILLIPS. There is such a fall that it will come along.
The CHAIRMAN. Suppose you went still farther up?
Mr. PHILLIPS. There is a sand region farther up that would make it difficult to get the water through?
The CHAIRMAN. You want to get below the sand?
Mr. PHILLIPS. We will have to do that, we think.
The CHAIRMAN. You can not raise crops in your vicinity without irrigation?
Mr. PHILLIPS. We can not raise corn.
The CHAIRMAN. Can you raise any other kind?
Mr. PHILLIPS. We can raise wheat, rye, and a half a crop of oats.
The CHAIRMAN. How much wheat?
Mr. PHILLIPS. Eight to 18 bushels per acre, but there is more of it at 3 and 5 bushels per acre than there is at 8.
The CHAIRMAN. How deep is it to water where you are?
Mr. PHILLIPS. One hundred and eighty-five feet.
The CHAIRMAN. You have not tried artesian water?
Mr. PHILLIPS. No.
The CHAIRMAN. Is there an abundance of water when you get down 185 feet?
Mr. PHILLIPS. Yes; we can run a wind-mill constantly with a 2-inch pipe and can not exhaust the supply of water at the bottom of the pipe.
The CHAIRMAN. Have you irrigated any land with wind-mills?
Mr. PHILLIPS. Not to any great extent?
The CHAIRMAN. Have you irrigated gardens?
Mr. PHILLIPS. People have irrigated their gardens that way. In the south part of the county there is a kind of surface spring water, and they had some little crops there. In the eastern part of the county it is lower and they have some better crops there. We do not see our way to farming there unless we can see our way to water.
The CHAIRMAN. Is there any way to store storm water there?
Mr. PHILLIPS. Yes; there are natural reservoirs all over there.
The CHAIRMAN. In these large natural depressions the water evaporates. You would have to find smaller ones.
Mr. PHILLIPS. We could get them of any size.
The CHAIRMAN. You have not tried to make ponds?
Mr. PHILLIPS. I have a small pond which is used somewhat for a fish pond.

The CHAIRMAN. If it would do for fish it would do for irrigation.

Mr. PHILLIPS. Certainly. We can pump water into it.

The CHAIRMAN. You can not fill it from storm water, then.

Mr. PHILLIPS. No. Our rains in the spring are heavy. From January to June we have had for three years past plenty of rain and after that time we have had scarcely any rain. If we had reservoirs prepared we would be able to store that early spring water.

The CHAIRMAN. And irrigation at the critical time would enable you to raise crops?

Mr. PHILLIPS. Yes; without any trouble.

The CHAIRMAN. If that section were surveyed carefully and plates for reservoirs located by scientific men of experience would it be useful to you?

Mr. PHILLIPS. I think it would. The majority of our farmers now think that the only thing to be done is to store the storm water.

STATEMENT OF JAMES ROBSON, OF JULESBURG, COLO.

The CHAIRMAN. What is your occupation?

Mr. ROBSON. I am in the banking business there.

The CHAIRMAN. Has your attention been called to the deficiency of moisture here for the purposes of growth of crops.

Mr. ROBSON. It has.

The CHAIRMAN. How long have you been here?

Mr. ROBSON. About two and a half years.

The CHAIRMAN. Have you looked over the country to see what the conditions were by which farming might be improved and moisture obtained?

Mr. ROBSON. Yes.

The CHAIRMAN. We shall be glad to have any statements you think proper to make in regard to the matter.

Mr. ROBSON. The land I speak of is between the North Platte and the Lodge Pole Creek, and between the one hundred and second and the one hundred and fourth meridians. From the time I have been in this country I have become convinced that to make a success of corn it is necessary to have more moisture. We have for that purpose, in our town, discussed the matter in our board of trade. There was a committee formed to investigate it and see whether there was any possibility of irrigating the region which I have mentioned, from Julesburg west and northwest. The committee engaged the services of an engineer of Denver, named Wilson, to go across this country and see whether there was any possibility of taking the water from the North Platte and bringing it over toward Julesburg and irrigating there. To make my remarks shorter, I will read a short paper that the committee prepared yesterday, after they learned that your committee was to meet here.

The paper is as follows:

Our object in laying this scheme before the committee is to call your attention to it, and give it prominence and recognition as an undertaking of great importance and value to a large number of people in one of the most fertile regions of western Nebraska. The practicability of ditching from the North Platte River, at a point northwest of Julesburg about 100 miles, across the table-land, has been established by a preliminary survey. The proposed route is from a point on the North Platte River, near Camp Clark, on to the table-land, and in a southeast direction to Julesburg.

[illegible]rard to the quality of the section of country to be irrigated, we would say [illegible]believe that no stretch of country approaching this to any degree in scope [illegible]as has been irrigated in the West.

The soil is first-class; no sand or gravel to be found in the entire distance except in the river bottom.

From the point where the projected route strikes the table land to the terminus there is not one acre of inferior land, and no area can be found that will irrigate to better advantage.

A ridge or divide extends almost the entire route, thus allowing the water to be conducted both ways for many miles. The river bluffs are composed of soil and soft rock. The river bottom contains some sand, the same as is found all along either valley of the Plattes. The survey, which was made by Mr. C. A. Wilson, a civil engineer of Denver, found the fall of the North Platte River to be 10 feet to the mile, and the height of the bluffs about 350 feet. The fall of the table-land is about 7 feet to the mile, the general trend being to the southeast from the starting point. The scope to be irrigated is on an average about 25 miles in width; beautiful, level-lying land, with a ridge running along the center, this making it easy to irrigate the whole scope.

The committee believe that this project bids fair to open up the richest part of the West, and make the whole tract embraced within the scope of the ditch a perfect garden, and the people a rich and prosperous community.

That no ditch in the West would be more profitable to its constructors and satisfactory to its operators.

Mr. ROBSON. I would say in regard to the water supply that the North Platte has always afforded an abundance of water, and that the engineer at the time he was there, just about a year ago, said that there was then an abundance of water for the supply of three or four or half a dozen such ditches as would be necessary to irrigate that region, probably, at that time. The inhabitants around the river there have been there for a great number of years; they said they never knew the river to be so low, although it is probably lower now than it has ever been. Still, if the river did not afford enough surplus water running, I think the possibility of obtaining water enough by creating dams in the gravel is very great, and would be successful. All through this whole region of country there is an underlying stratum of water that is practically inexhaustible. That has been demonstrated without any dispute. It is necessary that dams should be built if anything is to be made out of that country in the way of agriculture. I think that by building dams and running down into this gravel-bed a water supply can be obtained. It may be expensive, but the water is there.

The CHAIRMAN. Do you think an investigation by the Government as to the best mode of doing it, and where the water can be obtained and estimates of cost and reservations made for reservoir sites would be valuable to the people here?

Mr. ROBSON. Very valuable, indeed.

STATEMENT OF C. A. WALKER, OF OGALALLA:

The CHAIRMAN. What is your occupation?

Mr. WALKER. I am county surveyor of this county.

The CHAIRMAN. You are familiar, I suppose, with the water supply about here?

Mr. WALKER. Yes.

The CHAIRMAN. Have you made any surveys in reference to irrigation?

Mr. WALKER. Yes.

The CHAIRMAN. You may state, in your own way, what you have done, and give us your views with regard to irrigation.

Mr. WALKER. I made one preliminary survey on the south side of the South Platte River, beginning at the Colorado line and extending it about 23 miles east. From what I have done I should think a water-supply could be easily obtained at that point, and a ditch could be built

at very little expense. There are about 30,000 or 40,000 acres of land that could be put under ditch.

The CHAIRMAN. If a ditch were commenced at that point would it get onto the table-lands?

Mr. WALKER. Not so far down as I came. I should think it would take 30 or 35 miles to do that.

The CHAIRMAN. Can you not go up higher to better advantage, and get a ditch on to the table-lands, or are you in the sand belt?

Mr. WALKER. No. I could have gone 30 or 35 miles further up the river, and by that means it would get to the table-land.

The CHAIRMAN. Would not that be a better place?

Mr. WALKER. I think likely it would.

The CHAIRMAN. How would you get the water from the river?

Mr. WALKER. By means of a gallery going down into the gravel bed.

The CHAIRMAN. Is that ditch going to be constructed?

Mr. WALKER. I do not know.

The CHAIRMAN. What chance is there for storing storm-water on the south side of the river?

Mr. WALKER. There are very good chances. On the south side—in fact, on both sides—of each of the rivers, the North and South Plattes, there are lagoons, the lower parts of which could be dammed up, and I think a great deal of storm-water could be saved.

The following papers were received and filed. The committee then adjourned, to meet at Washington, D. C., on the call of the chairman:

STATMENT OF A. D. SCHERMERHORN, ENGINEER NEBRASKA DIVISION OF THE UNION PACIFIC RAILWAY.

The main line of the Union Pacific Railway, from the one hundredth meridian west to Cheyenne, passes through the western part of Nebraska and eastern part of Wyoming. Along this line the water supply of the road is, with two exceptions, derived entirely from wells, which give a supply ample for all uses of the company. The road lies along the South Platte River and Lodge Pole Creek, and the wells are sunk on this line, varying in depth from 12 to 30 feet east of Potter Station, and west of there from 35 to 120 feet deep. In sinking these wells trouble was often had on account of quicksand.

Following is a list of wells along the above line, with depth, quantity, and quality of water, etc.:

Station.	Depth.	Diameter.	Quantity.	Quality.
	Feet.	*Feet.*		
Willow Island	12½	12½	Ample..	Fair.
Brady Island	12	12	..do ...	...do.
Maxwell	10	12	....do ...	...do.
North Platte	70	*	Limited.	Good.
O'Fallon's	15	9½	....do ...	...do.
Paxton	19	12	Ample..	...do.
Ogal lla	10	12	....do ...	...do.
Julesburg	18	12	.. do ...	...do.
Weir	17	9½	Limited	...do.
Lodge Pole	17	9½	....do ...	...do.
Sidney	35	12	Ample..	.. do.
Potter	30	9½	... do ...	...do.
Bushnell	40	9½	Limited.	...do.
Pine Bluffs	40	9½	Ample..	...do.
Egbert	35	9½	....do ...	...do.
Hillsdale	60	9	Limited.	...do.
Atkins	120	12	....do ...	Fair.

* Four 3-inch pipes.

r less alkali is found in the water of all the above wells. At Big Springs the derived from a spring on the hill, from which a pipe line is laid to the tank,

it being a gravity supply. The water is of good quality, but the supply is limited. At Kimball the water is pumped from Lodge Pole Creek, about 1 mile from the road, direct into the tank. The supply is ample and the quality good.

No storage system in use on the road. No record has been kept by this department of the rain-fall in this part of the State. The rain-fall is light, and what there is generally occurs between the months of January and July.

There are no irrigation enterprises in successful operation, though several plans for the same have been talked of.

At Kearney there is a canal running from the Platte River, which furnishes water power, but is not used for irrigation purposes.

STATEMENT OF ABBEN WOODCOCK, GENERAL LAND COMMISSIONER OF THE UNION PACIFIC RAILWAY COMPANY.

The Union Pacific Company has never made any surveys relative to irrigating its lands. Neither has it at any time published maps or reports on the subject of irrigation. We have nothing in print relative to the matter.

The subject of irrigation is a very important one. The solution of the problem, "How can the millions of acres of our arid lands be irrigated?" may well engage the best minds of our country, and especially enlist the attention of Congress.

There is no more beautiful country in the world than that which lies between the Missouri River and the Rockies, "The great divide of our continent." Richer land the sun does not shine on. The west third of this lovely country is mostly unproductive for the want of water. Where water has been applied to its soil vegetation springs up like magic and grows and blooms with all the luxuriance of a flower garden. Its yield of vegetables, the cereals, and of fruits is very prolific, and the quality is of the very best.

In Colorado, the land to yield must be irrigated. This is also true of Wyoming, Idaho, Utah, Arizona, New Mexico, Nevada, and the south of California.

In Colorado, east of the mountains, the rivers and streams are already tapped by irrigating ditches; and in the driest part of the season hardly furnish sufficient water to irrigate the lands that are already under cultivation. The South Platte, in its meandering course through Nebraska, is but a bed of sand, the water having been taken from it in Colorado. The same may be said of other streams that have their source in the Rockies. In the dry season but little water through these channels reaches the Missouri.

It is supposed that if the few floods that swell those streams in summer were gathered into reservoirs, sufficient water would be furnished to irrigate the lands which are now under cultivation. At present this is not the case. But how can water be procured to irrigate the millions of acres in Colorado that are yet uncultivated and can be used only for grazing land?

In the spring-time of the year the melting snows of the mountains come thundering down the rocky defiles of the mountains in cascades, and the rain-storms at times pour in torrents. These swell the creeks and streams to overflowing, but soon are carried away in swiftly-running currents and are lost in the great rivers on their way to the sea. How can the priceless waters of these spring floods be saved to the parched up and thirsty country? By collecting them into numerous and extensive reservoirs throughout the country. These reservoirs must be strongly and scientifically built. Large canals and ditches must be so constructed that the waters in flood time may be carried from the creeks and rivers at a high elevation into these reservoirs. No water of flood-time must be allowed to escape as long as there may be room in the reservoirs.

There would, of course, be a constant loss of water from the reservoirs by seepage into and through the ground. The water that would escape by seepage would again appear to the surface in the form of springs and little rivulets. These would break out in low depressions of the ground, in ravines, and small valleys.

These springs and rivulets would be utilized by the farmer in watering his stock or in irrigating his orchards and garden.

Reservoirs might be made in the creeks and rivers themselves by building good and substantial drains at certain available places along their courses.

Mr. Gilmore, general manager of the Platte Land Company, Denver (who, by the way, has studied this subject for years), says that in Colorado they estimate that a stream of water equal to 1 cubic foot per second of time is sufficient for irrigating 50 acres. It is believed that could the vast amount of water that falls in spring and occasionally at intervals during the year be saved for irrigation, it would be amply sufficient to make the States and Territories above named bloom like a rose agriculturally. The cost of the construction of such reservoirs, canals, and ditches would be so great, that capitalists, as yet, have not dared to undertake the enterprise. Should our General Government lead off in this great enterprise by making the required sur-

veys in the different States and Territories where irrigation is a necessity, and inaugurate that great work, capitalists, and the people generally, would enthusiastically join in and give every aid in their power.

THE LANDS OF THE UNION PACIFIC RAILWAY COMPANY.

Nebraska.—As far west as North Platte, on the Union Division of the Union Pacific Railway, the country is agriculturally rich and most prolific in crops, and for some distance beyond Julesburg crops are raised successfully without irrigation. In the extreme western part of the State "dry farming" (as cultivation without irrigation is called) has not thus far been entirely successful. Good crops, however, at some seasons in the western part have been raised. The settlers have confidence and believe that ere long in the future the rain-fall will be amply sufficient. The amount of rain-fall from year to year has gradually increased. The rain-fall this year has been abundant and the prospects for an abundant crop are splendid. The company has practically sold its lands in Nebraska. It has but few pieces unsold. Irrigation I do not think is needed in any part of Nebraska.

Wyoming.—The company has sold all its land in this Territory as far west as Fort Steele, with the exception of a few sections. The land was sold for grazing purposes, with few exceptions, to men engaged in raising cattle. We have yet a large body of land in the western part of the Territory, at least 2,500,000 acres, lying on either side of Green River. I have no doubt that a great portion of this land lying west of Green River can be made highly productive and capable of sustaining thousands of people by constructing a canal that will tap the river high up towards its source, by means of which at least two-thirds of the company's as well as the Government's lands can be successfully irrigated. I ask that your committee investigate this subject when in Wyoming. There is no question about the richness of the soil; even that upon which the station of Green River is situated, which seems so sterile. When at that station, please look at the little inclosure of a Mr. Johnson, just south of our track. It is as green and beautiful as a Washington City park—the effects of irrigation. Owing to the high altitude of Wyoming, Indian corn can not probably be raised, but other crops will be a success. Eastern Wyoming is very similar to western Nebraska, and but little irrigation will be necessary. I am of the opinion that the North Platte, flowing through the southeast of this Territory, can be made to yield its waters to portions of land in that part of the Territory. The same may be said of Bear River, in the western part of the Territory. The unsold Wyoming land has up to this date been a source of outgo to the company in the shape of fees paid for obtaining patents and the yearly taxes, and has furnished no income. It now seems probable that these payments will have amounted to so much by the time this land is sold as to largely reduce the net revenue of the company from this portion of its grant.

Colorado.—The company has over 2,500,000 acres of land in this State. The greater portion can be used alone for grazing purposes unless irrigated. In the extreme eastern part of the State settlers on quite a large area adjoining Kansas and Nebraska have been trying farming, but with varying success. To insure crops even here irrigation is necessary. I have written more fully of this State in the commencement of this letter.

Idaho.—The company had no land grant in this Territory, but owing to its Oregon Short Line, and Utah and Northern Railway, it has great interest in the Territory. The land is very rich. The Snake River, having its source in our National Park, and meandering through the central and west portion of the Territory, is capable of irrigating millions of acres, and of making the south half of this Territory as productive and rich as any part of our country. The climate is admirable, and when water touches its soil vegetation seems to spring up spontaneously.

Utah.—The company has a little over 400,000 acres of land in Utah. The greater part of this land is situated in the eastern part of the Territory, adjacent to Wyoming, and is very broken and mountainous. At present the greater portion of it is fit only for grazing purposes. The land in Utah, without exception, must be irrigated to produce agriculturally. The surface of the country is broken into high hills and mountains, very rich valleys intervening. Much of the land can never be reached with water, but many valleys can be irrigated by the outlay of capital, and when irrigated will become surpassingly beautiful like that of Salt Lake. As is well known, the climate of this Territory is superb, and in salubrity can not be excelled. A great many of the valleys are well settled, but there is a large body of land in nearly all of these which can not be farmed either because water is scarce, or can not be got upon it from the streams. A system of water supply from Utah for irrigating purposes would unquestionably open up large and fertile areas in many of the very productive valleys in which the Territory abounds, and be the means of adding a large population to a country blessed with an invigorating and healthful climate and a capacity for producing many and varied crops, not the least of which are fruits of the best quality known.

Kansas.—The company has sold a vast amount of land in Kansas, there remaining yet unsold upwards of 700,000 acres. This land is first class, and lies in the western part of the State. Here irrigation is not needed. The maturing crops at this season of the year were never better, and there is every indication of a very abundant harvest. The air is pure and bracing and the climate healthful.

I am well aware that I have not treated this subject in the manner you wish. What you desire is succinct and definite information as to the practicability and feasability of irrigation in these different States and Territories. As I said, this department has never made any surveys or studied the subject relative to irrigating the company's lands. I am therefore unable to treat the subject in the practical manner it should be.

STATEMENT OF AUGUST V. KAUTZ, COLONEL EIGHTH INFANTRY, COMMANDING AT FORT NIOBRARA.

The Niobrara River flows near the northern line of the State almost its entire length from west to east. The current is very rapid and the volume of water may be roughly calculated by assuming an average depth of 2 feet and an average width of 150 feet. It is a remarkably constant stream, subject neither to droughts or floods. In the past two years it has not varied more than 2 feet between the highest and lowest water. A large portion of the country through which the river flows is sandy and subject to drought, and its value would be vastly increased if the land north and south of the river could be irrigated. The highest areas are not more than 200 feet above the stream, but many large areas are not half so high. The fall of the river is so great that it would seem highly probably that much if not all the land in the vicinity of the river could be reclaimed.

The constant character of the river is due to the fact that it is supplied entirely by springs. The country is underlaid by an impervious strata which forces the surface water it has passed through the sand that overlies it to drain into the river through the springs, thus making the water supply constant and unvarying. The river-bed has cut down into this strata about 100 feet in the cicinity of this post. Beyond this fact the thickness of the strata is not known. Its impervious character, however, suggests the great probability that artesian water could be obtained by boring through it. The material of the strata is a white earth, alkaline, and sufficiently firm to present a perpendicular wall along a great portion of the river, but as far as known it can be bored as easily as chalk. The nearest flowing well to this point is at Fort Randall, on the Missouri River, about 125 miles east of this post. Its depth is said to be something over 600 feet. If the fact could be demonstrated that artesian water could be obtained within 1,000 feet of the surface it would be of incalculable value to this portion of the State.

STATEMENT OF J. S. POLAND, LIEUTENANT-COLONEL TWENTY-FIRST INFANTRY, U. S. ARMY, OF FORT SIDNEY.

My experience in this department is not extensive enough for me to make any valuable suggestions, but I wish to remark that while stationed at Fort Bridger it occurred to me that portions of the country near that post could be made fertile by raising water from an unfailing stream, the Black Fork of Green River, into reservoirs at suitable places along its banks, as can be determined by barometric survey, and large portions of the country reclaimed by irrigating ditches. The soil is fertile and needs only proper moisture to produce anything. I am not prepared to confirm the assertion of a prominent geologist that the plains of southwest Wyoming may yet furnish a valuable fertilizing soil for worn-out districts.

STATEMENT OF E. W. STONE, CAPTAIN COMPANY A, TWENTY-FIRST INFANTRY, U. S. ARMY, OF FORT SIDNEY.

My experience in irrigation has been such only as applies to the cultivation of a company garden. For the successful cultivation of a garden, growing of trees, in fact any product of the earth, on the plains, and I might say through the entire West, irrigation to a certain extent is necessary. In the few places that have come under my observatiou no organized system has been adopted. Generally streams of water have been tapped, and water, without regard to quantity required, allowed to flow over the surface without means being provided for conducting that not required back to the stream, thus allowing great waste which, as the country settles, causes a scarcity, and in many cases trouble.

[illegible] rigation by flooding the surface is common, which, in my opin-
[illegible] en the flow of water is stopped, the heat and dry atmosphere
[illegible] to a hard crust, thus preventing the air from penetrating to
[illegible] ts, etc., which is essential to a healthy growth. I have met with
[illegible] irrigation by means of narrow trenches leading from a main ditch,
[illegible] is absorbed in the earth around the roots of the plants and the
[illegible] eft free and opened.

[illegible] post means of irrigation are furnished from Lodge Pole Creek, the water of
[illegible] conducted to the post by a military ditch tapping the creek about a mile
[illegible] lf above the post, by which means 20 acres in vegetables are sucessfully cul-
[illegible], fine grass plats and a luxurious growth of trees are maintained about the
[illegible]. In this section, as settlers increase, additional acreage comes under cul-
[illegible]. and timber claims planted, the rain-fall sensibly increases ever year, thus
[illegible] the demands for irrigation.

[illegible]air of the County Agricultural Society held at Sidney last year many fine
[illegible] of vegetables and small grains, raised without irrigation, were exhibited.
[illegible] are only offered for such exhibits as are raised without irrigation in this
[illegible].

[illegible]ENT OF H. L. BAILEY, FIRST LIEUTENANT AND REGI-[illegible]AL QUARTERMASTER TWENTY-FIRST INFANTRY, U. S. [illegible], OF FORT SIDNEY.

[illegible]erved the system and results of irrigation over wide tracts of dry deserts in
[illegible], Washington, Idaho, Utah, and elsewhere. In Utah, lately, capitalists are
[illegible] companies to construct and control great ditches or canals, which will give
[illegible]ower to heavily tax thousands of farmers. Such projects are in contempla-
[illegible]elieve, in this vicinity of Nebraska. The South Platte River throughout this
[illegible] destitute of water in summer in consequence of the use of its water in irri-
[illegible] in Colorado. The taking of the water should be regulated by law. The soil
[illegible] deserts I have mentioned is very rich in agricultural ingredients, and needs
[illegible]ater. The North Platte, 70 miles north of this place, could, I doubt not, be
[illegible] to irrigate many thousands of acres of Wyoming and Nebraska. I have not
[illegible]ver the ground personally, but I think it would be easy to conduct its waters
[illegible] little valleys along the Union Pacific Railway. The benefit of such spread
water would extend beyond mere wetting of the soil, as the effect of the moist-
[illegible]nd resulting vegetation would in time so modify the climate as to produce more
[illegible]ain and dew.

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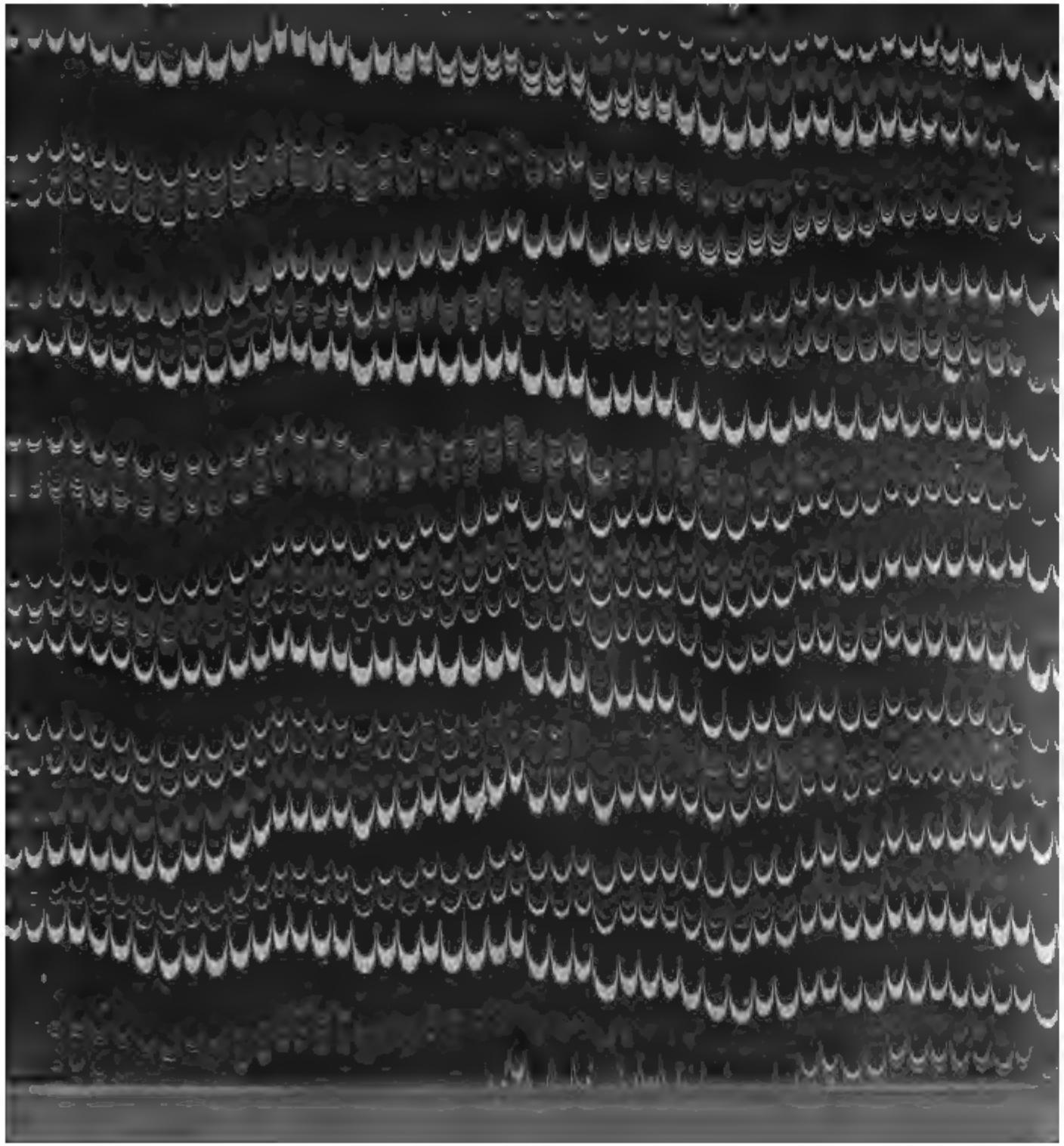

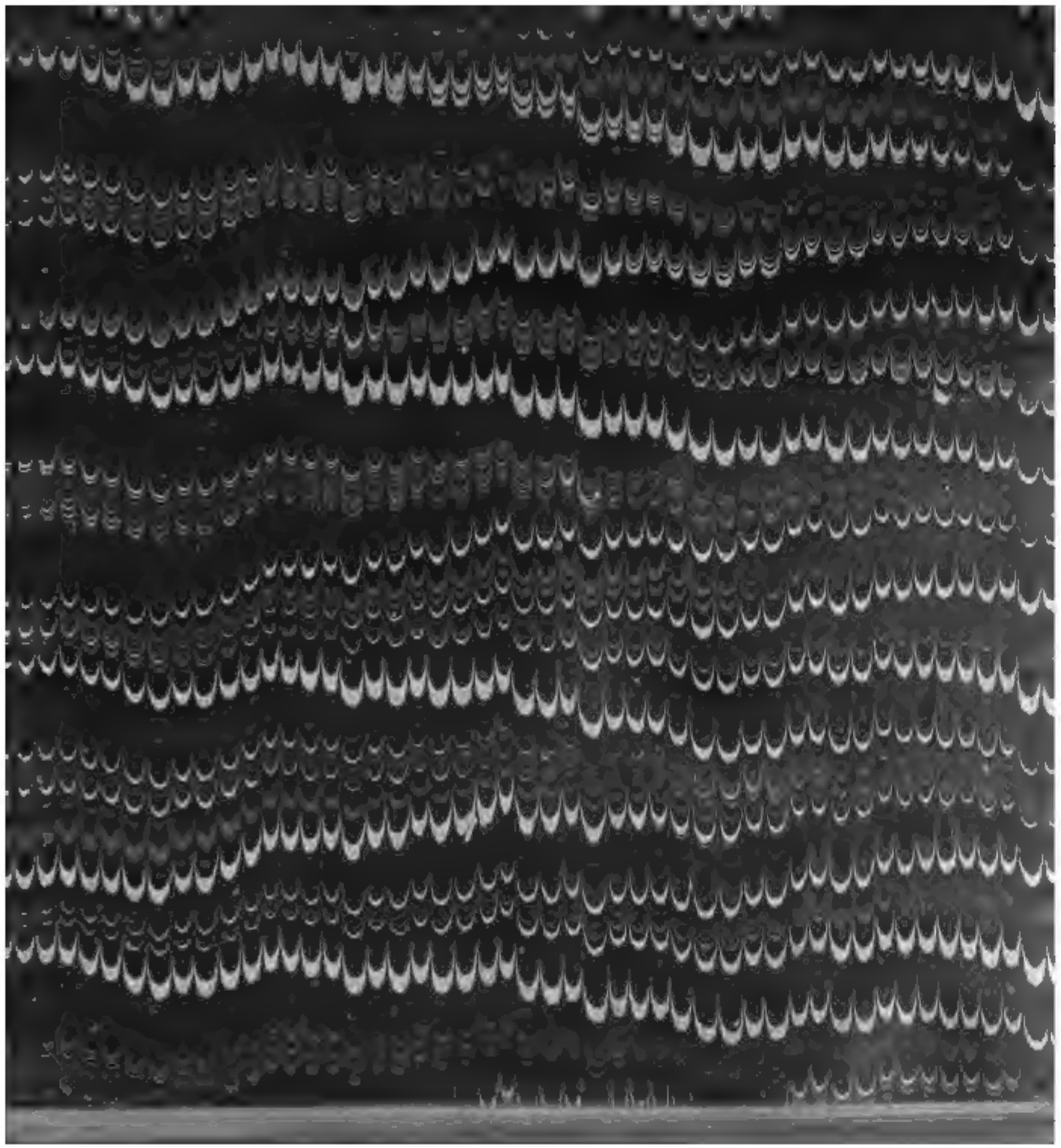

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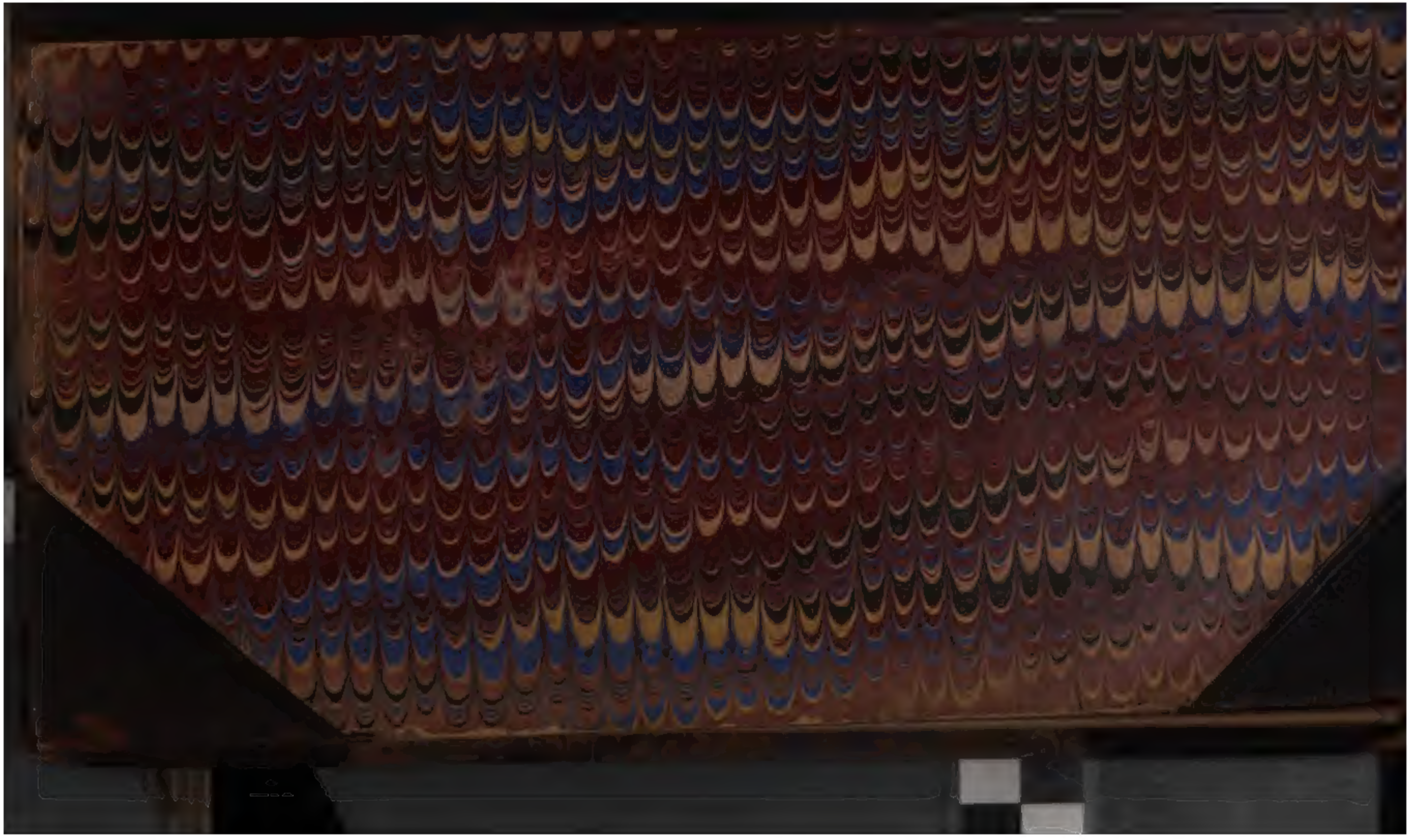
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